# Appendices

## Appendix A - Boundary Legal Description

The tidelands and bedlands of navigable waters, owned by the State of Washington, described as follows:

Those tidelands and bedlands surrounding Maury Island, which are fronting and abutting Government Lot 4, excepting there from the west five acres, of Section 14, Sections 20-23, inclusively, and Sections 28-32, inclusively, Township 22 North, Range 3 East, W.M.;

Together with, those tidelands and bed lands lying westerly of said Maury Island which are fronting and abutting only those portions of Sections 9 and 16, which are fronting on Quartermaster Harbor, Township 22 North, Range 3 East, W.M.;

Together with, those tidelands and bedlands lying southerly of said Maury Island, which are fronting and abutting Sections 5 and 6, Township 21 North, Range 3 East, W.M.; and said reserve extends waterward to a water depth of 70 feet below mean lower low water OR one-half mile from the line of extreme low tide, whichever line is further waterward.

Those tidelands and bedlands lying southerly and easterly of Vashon Island, which are fronting and abutting Section 1, Township 21 North, Range 2 East, W.M.;

Together with, those tidelands and bedlands lying easterly of said Vashon Island, which are fronting and abutting Sections 24, 25, and 36 Township 22 North, Range 2 East, W.M.;

Together with, those tidelands and bedlands lying easterly of said Vashon Island, which are fronting and abutting Sections 17-20, inclusively, Township 22 North, Range 3 East, W.M.;

Together with, those tidelands and bed lands lying southerly and westerly of said Vashon Island, which are fronting and abutting only those portions of Section 8, which is fronting on Quartermaster Harbor, Township 22 North, Range 3 East, W.M.; and said reserve extends waterward to a water depth of 70 feet below mean lower low water OR one-half mile from the line of extreme low tide, whichever line is further waterward (Figure 1).

Situated in King County, Washington.

Prepared by Steven B. Ivey, PLS
Date: May 7, 2004

# Appendix B - Administrative Lead and Cooperative Management Entities

- **King County:** King County is the primary manager of adjacent land use through the King County Comprehensive Plan, King County Shoreline Master Program, and King County Code. King County Parks also manages Dockton County Park and the Maury Island Marine Park. The DNR will seek to work consistently with the existing regulations and management plans administered by King County Water and Land Resources Division, Department of Development and Environmental Services, the Maury Island Aquatic Steward, King County Department of Natural Resources, and King County Parks and Recreation.
- **King County Noxious Weed Control Board**: The King County Noxious Weed Control Board sets county weed control priorities, annually adopts the county weed list, and administers the Noxious Weed Control Program throughout the County according to the requirements of RCW 17.10. The Board also provides education to the public by informing them of the County weed list, why it is necessary to control noxious weeds, and appropriate methods of eradication or control.
- **King County Conservation District**: The King Conservation District (KCD) is a natural resources assistance agency authorized by the State of Washington and guided by the Washington State Conservation Commission. The KCD promotes conservation through demonstration projects, educational events, providing technical assistance, and, in some cases, providing or identifying funds that may be available for projects. The KCD has no regulatory or enforcement authority and only works with those who choose to work with them.
- **Washington Department of Fish and Wildlife (WDFW)**: The WDFW has authority over the management of commercial and recreational fisheries, including shellfish harvest licensing and seasons. The WDFW also helps protect aquatic resources from degradation through its Hydraulic Project Approval (HPA) process. The WDFW plays an important role in the management of the reserve in oil spill response, ballast water monitoring, and Natural Resources Damage Assessments. The DNR will seek to cooperate with the WDFW North Puget Sound Region (Region 4), Marine Protected Area Program, Fish Program, and Habitat Program to aid in achieving the goals for the reserve.
- **Washington Department of Ecology (Ecology):** The Department of Ecology manages oil spill response, wastewater discharge, oversees the state shoreline master program, and administers state water quality standards. The DNR will seek to cooperate with Ecology's Northwest Regional Office and Stormwater Section.
- **Washington State Deparment of Health:** The Washington Department of Health (WDOH) regulates commercial harvest of shellfish and advises the public on the healthy recreational harvest of shellfish. The DNR will seek to cooperate with WDOH's Food Safety and Shellfish programs.

- **U.S. Coast Guard:** The U.S. Coast Guard manages vessel activity and responds to pollution reports within Puget Sound through the Marine Safety Office. The Coast Guard also helps ensure the safety of vessels during transit and while in port.
- **U.S. Army Corps of Engineers**: The Corps of Engineers supports navigation through the maintenance and improvement of water channels, development projects to reduce flood damage, and regulation of dredging and filling activities in wetlands and waterways of the U.S.
- **U.S. Fish and Wildlife Service:** The U.S. Fish and Wildlife Service is charged with protecting plant, terrestrial animal, and some fish species listed under the federal Endangered Species Act and the Migratory Bird Treaty Act and the habitats those species rely upon. They are also mandated to coordinate with state agencies through the Fish and Wildlife Coordination Act.
- **National Oceanic and Atmospheric Administration-Fisheries (NOAA-Fisheries):** NOAA-Fisheries is responsible for the protection of marine mammals and anadromous fish species under the federal Endangered Species Act, the Magnuson-Stevens Act and the Marine Mammal Protection Act. NOAA-Fisheries is also charged with conservation and protection of living marine resources within the United States Exclusive Economic Zone.
- **Puyallup Tribe:** Tribes are responsible for managing tribal harvests of fish and shellfish species, protection of historical and cultural resources, and management of tribal lands. The tribes also co-manage the state’s fisheries resources along with WDFW and DNR (geoduck fishery).
- **Vashon Parks District:** The Vashon Parks District manages Burton Acres and the Point Robinson parks.
- **Non-Governmental Organizations:** A wide variety of non-governmental organizations play important roles regarding citizen representation for environmental protection, property rights, education and outreach, and monitoring. These entities include the Vashon Community Council, Vashon/Maury Island Land Trust, Preserve Our Island, Vashon Audubon, and People for Puget Sound

# Appendix C – Aquatic Reserve Habitat and Species Description

The nearshore environment along the reserve is a complex, productive environment that provides important habitat structures and ecosystem functions for a wide variety of aquatic flora and fauna. While urbanization and human development have altered much of the nearshore environment in the Central Puget Sound, much of the habitat along the reserve remains relatively unaltered, which makes it a crucial component of the area's aquatic environment. Achieving preservation of this area requires an understanding of the processes, functions, species assemblages, species abundance, and habitat types so that management strategies can be developed to best protect the aquatic resources at the reserve. While the reserve area is limited to those submerged lands managed by DNR that are in state ownership, approximately 88% of the tidelands adjacent to the reserve are in private ownership. This section examines all natural resources found in the vicinity of the reserve, including those on privately owned and managed lands adjacent to the reserve.

## 1.0 Physical Environment

### 1.1 Ecological Zones

The reserve can be effectively divided into three ecological zones (Figure 2 in main body). The lines delineating the differences between each of these zones are neither exact nor constant and may change seasonally or annually as a result of local environmental conditions. Inner Quartermaster Harbor is the most protected part of the harbor with very weak or indeterminate currents during most tide and wind conditions (Turnbeaugh 1975). The subtidal sediments in this area are classified as mud, but the mud is much deeper than areas in Outer Quartermaster Harbor (Blau 1975). The delineation between inner and outer Quartermaster Harbor is the transition area between Burton Peninsula and Raab's Lagoon. With the exception of the Dockton area, outer Quartermaster Harbor experiences much higher wave exposure, currents, and circulation. The waters in outer Quartermaster Harbor are still warmer, less saline, and have a higher residency time than waters offshore of Maury Island's east shore. The east shoreline of Maury Island from Piner Point to Point Robinson is much more exposed and grades to deeper offshore waters.

### 1.2 Hydrology

#### 1.2.1 Freshwater

An estimated 61 streams and outfalls empty into the reserve with the majority draining into Quartermaster Harbor (Anchor Environmental 2004). Larger, perennial streams on Vashon and Maury islands generally originate from groundwater seeps in higher elevation areas (300 to 500 feet above sea level). In these higher elevation reaches, the streams are typically low gradient and meander across the landscape. As the streams approach the marine shoreline, elevations change rapidly and water flows through a network of high-gradient ravines before entering Quartermaster Harbor. Streams with lower flows and smaller watershed areas generally originate in steeper gradient reaches (10 to 15 percent) and flow rapidly to marine waters (Kerwin and Nelson 2000).

Maury Island is not divisible into watersheds, and it appears that the majority of freshwater flow from the island enters Quartermaster Harbor through intermittent creeks and freshwater seeps. Two watersheds, Judd and Fisher creeks, flow into Quartermaster Harbor from Vashon Island (Appendix E). Judd Creek has an annual base flow of approximately 2.0 cubic feet per second (cfs) at the mouth and drains about 3,149 acres. Fisher Creek has an annual base flow of approximately 1.0 cfs, with a drainage area of about 1,549 acres (Kerwin and Nelson 2000). Limited water quality monitoring was undertaken in these tributaries in the early 1990s and Judd Creek was found to comply with all state standards. Although several samples from Fisher Creek exceeded the acute standard for lead, the Creek was within limits for all other parameters (Kerwin and Nelson 2000). The Burton Water Company withdraws water from Fisher Creek for domestic use, which may limit base flows during low flow periods.

Freshwater seeps along the marine shoreline are known to exist, but the number of seeps and the amount of water entering the reserve through freshwater seeps is unknown.

### 1.2.2 Estuary

The Puget Sound is a large estuary, where fresh and marine waters mix. Estuarine waters function as a partially blended, two-layer system, with less saline surface waters flowing seaward and denser, more saline ocean water returning landward at lower depths. Surface water flows can be augmented by inflow from any number of rivers and streams throughout the estuary. While there are several large rivers and a multitude of smaller streams in the general region, the bulk of the freshwater flowing into the Central Puget Sound Basin comes from the Puyallup and Duwamish Rivers, which account for 20 percent of the total drainage area. Tidal energies in the Central Basin are relatively strong and the water mixes freely throughout most of the year. However, during summertime dry seasons, stratification increases as freshwater inputs decrease (Williams et al. 2001).

The accumulated data indicate that Quartermaster Harbor is subject to wide seasonal fluctuations of most oceanographic and water quality parameters and is typical of a shallow Puget Sound embayment with a relatively high ratio of drainage area to receiving water (NORTEC 1984). An estimated 61 streams and major outfalls empty into the reserve with the majority draining into Quartermaster Harbor (Anchor Environmental 2004). Rainy winters and dry summers common to the Pacific Northwest drive observed seasonal variations. The wetter winter period causes marked declines in salinity, pH and temperature, while coliform bacteria levels increase (NORTEC 1984; Turnbeaugh 1975). While vertical salinity gradients are generally present within Quartermaster Harbor, observations vary in how pronounced these gradients are, with Turnbeaugh (1975) noting more pronounced gradients than NORTEC (1984).

Quartermaster Harbor is a rather shallow embayment that covers approximately 3,050 surface acres with water depths in the inner harbor averaging about 16 feet, while in the outer harbor water depth averages approximately 72 feet and reaches maximum depths of about 100 feet (NORTEC 1984). Circulation within the harbor may be reduced due to the closure of a historic opening at portage; however, circulation appears to be adequate to flush Quartermaster Harbor (Turnbeaugh 1975). An area of "less active" circulation is located between Judd Creek and Burton Peninsula. The implication is that water-polluting activities in less active regions should be minimized or completely eliminated to achieve and maintain adequate water quality standards (Turnbeaugh 1975). Historically, water flowed freely in and out of the harbor during high tides through an inlet known locally as "portage" located between Vashon and Maury Islands. Portage, is an isthmus connecting Vashon and Maury Islands. While George Vancouver's initial observations of the islands in 1792 indicate only one island, Captain Charles Wilkes charted two islands in 1841 (Lynn 1974). The opening was closed through the construction of two roads, one from Portage to Ellisport in 1916 and another from Portage to Dockton in 1925 (Van Olinda 1935). Current water movement is primarily northward into the harbor. While water quality impacts resulting from the complete enclosure of Quartermaster Harbor are not fully understood, the decrease in flushing may have led to an increase in the harbor's water temperature regime and may be contributing to eutrophication (Battelle et al. 2000).

Several stream mouth estuaries or stream-influenced areas exist within Quartermaster Harbor (Appendix E). These sites are of particular importance as habitat and refuge for juvenile salmonids and are a source of detritus and nutrients for food webs in the harbor. However, human-caused inputs into the streams may also cause negative impacts to water quality in Quartermaster Harbor.

Along the eastern shore of Maury Island, water depth increases rapidly across moderate to steep slopes to approximately 540 feet (152 meters) in the main channel of southern Central Puget Sound (Battelle et al. 2000). This reach of shoreline is considered semi-protected, with lower wave energy than other locations in the Puget Sound region. The northerly transport of surface waters along the shoreline is believed to concentrate plankton and nutrients along the beach, providing relatively high levels of primary production.

No information was found pertaining to water quality sampling along the eastern shore of Maury Island, although the waters in the area are considered "extraordinary" and are therefore subject to the most stringent state standards.

### 1.3 Geology

The Maury Island site is underlain by glacial till, sand, and gravel. Glacial till is a relatively unsorted mixture of clay, sand, gravel, and rocks (ranging in size from pebbles to boulders) left by receding glaciers. The source of the till in the area is from the Vashon glacier that occupied the Puget Sound basin approximately 13,000 to 16,000 years ago. Till in the Puget Sound is often thick, sometimes 100 feet or deeper (King County 2000).

The soil and sediments near the surface of the nearshore and bedland areas of Maury Island are most likely derived from submarine erosion and glacial bluff erosion along the shoreline. In Quartermaster Harbor, tributary streams such as Judd and Fisher creeks also deliver sediments (Appendix E). While the upper intertidal substrates include mud, sand, gravel, and cobble, the lower intertidal is predominantly sandy and more than 90 percent of the subtidal areas within Quartermaster Harbor are classified as mud (Blau 1975). For the central Puget Sound basin as a whole, Lavelle et al. (1986) found marine sediment accumulation rates of 0.003 to 0.001 grams per square foot per year (as referenced in Williams et al. 2001). These accumulations of material, primarily from bluffs, supply fine substrates to the intertidal zone, maintaining the structure and profile typical of central Puget Sound beaches (Bloch et al. 2002).

An inventory describing parts of the Vashon and Maury Island shorelines found that approximately 88 percent of the shoreline contained bluffs or banks, with an average height of about 44 feet. The highest banks were along the southeast side of Maury Island, where the elevation at the top of the bluff is more than 300 feet at some locations (Bloch et al. 2002). The bluffs in this area are composed primarily of glacial till and are important sources of sediments for surrounding beaches (Mumford et al. 2000). The shoreline inventory found that un-vegetated scars, usually an indication of a recent landslide and potential supply of sand to beaches, were continuous for seven percent of the Vashon and Maury Island shoreline, while 34 percent had patchy scars, and 36 percent had at least some undercutting at the base of the bluff or bank (Bloch et al. 2002).

1.4 Water and Sediment Quality

Based upon uses in the area, the Department of Ecology (Ecology) considers the waters within the Maury Island site as “extraordinary” (WAC 173-201A-210). Such waters have the most stringent water quality standards. There is limited water quality data for Quartermaster Harbor, although sampling conducted in the area was sufficient to prompt Ecology to include the embayment on the 1998 Washington State 303(d) list for violating state water quality standards for dissolved oxygen (DO) and dieldrin (Washington State Department of Ecology Water Quality Program 1998).

Section 303(d) of the federal Clean Water Act (CWA) requires that states keep an inventory of water bodies that violate water quality standards and that total maximum daily loads (TMDLs) be established for each parameter that is in violation of the standards. Ecology is currently updating the 303(d) list. Ecology’s recent draft 303(d) update for 2004 suggests that Quartermaster Harbor will not be included on the list (Washington State Department of Ecology Water Quality Program 2004). However, the site conditions have not necessarily improved and the site is being removed from the 303(d) list because no recent monitoring has taken place.

Water quality within Quartermaster Harbor has been adversely affected by several sources. Historic studies found a correlation between the presence of occupied vessels at the Dockton Park public dock and increases in fecal coliform populations in the water

(NORTEC 1984). The effect of sources other than boats to the overall bacteriological conditions appears to be significant (Bulman 1975). Possible sources impacting water quality include:

- Improperly functioning residential septic systems;
- Past and current agricultural and residential land use practices in watersheds surrounding the reserve;
- Residual contamination from historic commercial activities such as ship building and agriculture; and
- Boat wastewater discharges.

Concentrations of fecal coliform in Quartermaster Harbor tend to increase during the rainy winter months by as much as two orders of magnitude (NORTEC 1984). Judd Creek is a major source of coliform during the winter months as are other seasonal streams that drain non-point sources.

Water quality within the harbor has been adversely impacted by a number of human-related sources, including: failing residential septic systems; residential landscaping; gray water discharges from residences and/or boats; historic industrial activity; and both current and historic agricultural practices in watersheds surrounding the Maury Island site. In addition, elevated fecal coliform pollution and episodes of paralytic shellfish poisoning (PSP) have led to the decertification of several shellfish harvest areas within Quartermaster Harbor (Determan 2003b; WDOH 2004). The Washington State Department of Health (WDOH) monitors Quartermaster Harbor for fecal coliform to assess whether fecal waste is reaching the water and to determine whether pollution levels could be pathogenic. Recent reports suggest that certified shellfish growing areas in Quartermaster Harbor are not being adversely affected by fecal pollution (Determan 2003a).

While only three sets of water quality samples exist, these samples indicate that low dissolved oxygen (DO) conditions may be widespread and persistent within Quartermaster Harbor. In 1975, October observations found DO levels varied between a low of 3.80 mg/L at 16 feet deep within inner Quartermaster Harbor to a high of 6.30 mg/L at 25 feet deep near the mouth of Quartermaster Harbor (Turnbeaugh 1975). All fifteen Quartermaster Harbor observations from 1975 were below the extraordinary standard of 7.0 mg/L. Sampling in September 1982 found low DO levels (5.6 mg/L at 13 feet and 3.5 mg/L at 16.4 feet) at only one sampling station located between Judd Creek and Portage. February 1983 observations found that in addition to low DO at this sampling station (6.7 mg/L at 18 feet depth), one additional station, located near the Quartermaster Harbor Marina, also had low DO levels (6.6 mg/L at 14.7 feet). September 1983 observations found that low DO conditions were widespread within Quartermaster Harbor at depths of 16.4 feet or more with all sampling stations showing low DO conditions at or deeper than 16.4 feet (NORTEC 1984). DO levels observed in the Quartermaster Harbor in 1998 are described as being at a level that may begin to induce biological stress (Newton et al. 2002). Whether these low DO concentrations are being influenced by anthropogenic sources is a separate issue. However, as a result of chronic low DO levels, the harbor was placed on the 303(d) list in 1998. However, Ecology recognizes that the low DO levels observed were likely due to natural conditions. Under state water quality standards, in waters where low DO is a natural occurrence, levels may be degraded by up to 0.2 mg/L by human caused activities (WAC 173-201A-320).

Environmental contaminants can include those potentially arising from natural sources such as Paralytic Shellfish Poisoning (PSP). In both 2001 and 2002 Quartermaster Harbor had one of the highest index scores for PSP. Index scores are based upon the number of days PSP levels at the site exceed the Food and Drug Administration (FDA) action criteria as well as the magnitude by which PSP levels exceed FDA action criteria (Determan 2003b). PSP is the result of a toxin that accumulates in marine animals that feed either directly on toxic phytoplankton or on consumers of phytoplankton. As there is considerable uncertainty associated with the causative agent of PSP, it is not possible to determine whether its presence in Quartermaster Harbor is brought about by disturbed nutrient cycles in the area or by regional phenomena outside of the harbor. Although shellfish health is unaffected by the presence of the toxin, PSP is capable of causing mass mortalities among shellfish-eating animals such as birds, fur seals, foxes, sea otters, and humpback whales (Kvitek and Beitler 1988, Geraci et al. 1989). In addition, PSP can be harmful to humans that consume toxic shellfish. Due to concerns regarding fecal coliform levels and PSP, commercial geoduck tracts along the western shoreline of Quartermaster Harbor, including (X) tract 10300 (Appendix I), are not certified for harvest by the Washington Department of Health.

Sediment quality is degraded in portions of Washington’s waters as evidenced by chemical contamination, toxicity, and adverse alterations to benthic infauna. In studies of sediments from central Puget Sound, approximately 4.9 percent of the area sampled exhibited degraded or partially degraded sediment quality (Long et al. 2003). The majority of these contaminated sediments were found in highly urbanized areas such as Elliott Bay. Sediment Quality has been assessed for Quartermaster Harbor at a coarse scale as part of a regional assessment (Long et al. 2002). None of the three samples within Quartermaster Harbor showed high chemical concentrations, and one of the three stations showed no toxicity or chemical contamination and abundant and diverse infaunal assemblages. The other two stations were impaired for one of the three parameters – toxicity (Long et al. 2002). Examinations of groundfish tissue samples from Quartermaster Harbor found little contamination, suggesting that sediments in the area are relatively clean. Elevated concentrations of mercury and Polychlorinated Biphenyls (PCBs) were found in flounder samples, although the concentrations were similar to other non-urban bays in the central Puget Sound Basin (Crecelius et al. 1989). No exceedances of state criteria for sediment toxicity or chemical concentrations have been reported at the Maury Island site.

Complicating the water quality and PSP issues is the fact that Quartermaster Harbor is a poorly flushed system. The inner portions of the harbor are potentially nutrient sensitive and are showing signs of eutrophication (Harrison et al. 1994; Battelle et al. 2000). Assessments of sediment contamination within the harbor (utilizing fish tissue) showed relatively low levels of contaminants in fish, suggesting little risk to humans who consume fish from this area (Crecelius et al. 1989). However, elevated concentrations of two pollutants were found - flatfish contained elevated mercury levels, while PCB loads were in the higher range (201 to 2000 micrograms/kg) compared to other areas in Puget Sound. Although the fish tissue PCB levels were similar to other non-urban bays in central Puget Sound, they were higher than non-urban bays outside the sub-basin (Crecelius et al. 1989).

Tissue samples from fish in Quartermaster Harbor have been found to exceed the acute criteria for dieldrin. The Washington State standard for acute concentrations of dieldrin in marine waters is 0.71 µg/L or higher, with the chronic level 0.0019 µg/L or higher. Dieldrin is an insecticide that bioconcentrates in aquatic organisms and causes permanent hormonal changes in fish. Dieldrin readily binds to soil particles and as a result is persistent and widespread in the environment. While acute exposure in humans can lead to neurological effects such as headache, dizziness, and convulsions, the effects have not been shown to be permanent (GPA 2001). However, chronic exposure will lead to dieldrin bioaccumulation in humans and may be fatal (GPA 2001).

2.0 Ecological Processes

After sediments enter the marine environment, shore drift is the process for material transport along shorelines. A drift cell, or littoral cell, is a partially compartmentalized zone along the coast that acts as a somewhat closed system with respect to shore drift. Drift cells are systems in which sediment is suspended by waves or currents and transported along the shoreline in a cycle of suspension and deposition. The direction of shore drift is determined by the prevailing direction of the waves and currents in the drift cell. Direction of wave approach, and the resulting shore drift, may change frequently (e.g., daily, weekly, or seasonally), but over a long period of time one of the two directions along the coast will be the primary direction of net shore drift (Schwartz et al. 1991).

Drift cells are important because they are the mechanism that supplies the sediments needed to maintain nearshore habitat quality. Drift cells nourish sand and gravel beaches, provide fine sediments to tideflats, and maintain sand spits and other coastal landforms.

The Maury Island site contains a number of individual drift cells (Appendix D). Along the northern shore of Maury Island, drift occurs in a southeasterly direction toward Point Robinson. The eastern shore of Maury Island supports a nearly continuous, uninterrupted drift cell that runs 5.50 miles from the southern edge of the island, northeast to Piner Point to a convergence zone at Point Robinson, with no reversals in direction (Schwartz et al. 1991). The drift cell creates an eddy at the south of Point Robinson that provides feeding opportunities for juvenile fish. Point Robinson also provides the confluence of this drift cell with another that flows southeast along the northern shore of Maury Island (Schwartz et al. 1991). This drift cell is among the longest found in Puget Sound, and relatively uninterrupted drift cells such as this are becoming rare in the central Puget Sound basin. Healthy sediment drift and drift cells are critical for the maintenance and development of shoreline features, including forage fish spawning beds and vegetative communities. The drift of sediments within Quartermaster Harbor is primarily to the north, although there are local reversals of transport and convergence zones within the harbor where fine sediments are deposited in coves and embayments (Schwartz et al. 1991).

Nearshore drift has been significantly altered at two locations within Quartermaster Harbor. The second location where nearshore drift has been altered is in Raab's Lagoon, an area initially purchased for oyster cultivation that had a dike built for the road between Portage and Dockton (Van Olinda 1935). While the dike allows tidal exchange between the lagoon and Quartermaster Harbor, nearshore drift no longer enters the lagoon.

Nearshore drift throughout the reserve has been impacted by shoreline development. Shoreline hardening through the construction of bulkheads has increased wave energy in the nearshore and altered sediment movement along the shorelines. An estimated 13.75 miles or 57.6 percent of the shoreline within the reserve has been hardened or modified (Appendix M) (DNR 2001). Ramps, docks and piers can also impact water movements and drift cells. In addition to two public boat launches, seventeen private ramps have been identified within the reserve. Aerial photos show 84 overwater structures within and adjacent to the reserve that shade a minimum of 3.22 acres of habitat (Anchor Environmental 2004). Efforts to determine whether shoaling or sediment fill-in has occurred within Quartermaster Harbor suggest that any changes are below detection limits (Turnbeaugh 1975).

## 3.0 Vegetation and Habitat Resources

### 3.1 Estuarine and Shoreline Habitat

Sand and mudflats are gently sloping areas, generally surrounded by salt marsh communities that support a high biomass of aquatic invertebrates (i.e., clams, shrimp, and worms) and dense mats of microalgae (i.e., diatoms). They are highly productive areas and are a significant food source for shorebirds, fish, otters, and raccoons. Mud and sandflat communities are vulnerable to damage from floating structures that ground, increases in temperature associated with a loss of riparian vegetation, changes in substrate composition due to shoreline armoring, as well as increased nutrient and sediment loads and invasive plant introduction (i.e. *Spartina spp.*).

### 3.2 Upland Habitat

Upland land use and vegetation adjacent to marine shorelines affect the habitat and habitat quality of marine systems by affecting food sources such as the insect assemblages and freshwater hydrology. Perhaps the single most dramatic and pervasive impact of urbanization on the functions and values of a watershed is the replacement of the natural landscape with pavement and other water-impervious (impenetrable) material such as roads, parking lots, driveways, sidewalks, and rooftops. Increased levels of impervious surfaces interrupt the hydrologic cycle, alter stream structure, and degrade the chemical profile of the water that flows through streams. These changes affect fish and wildlife in various ways, and are cumulative within watersheds. Research indicates that when the total impervious area (TIA) in a watershed reaches 10 percent, stream ecosystems begin to show evidence of degradation (Booth and Jackson 1997). Only one of the four watersheds adjacent to the reserve approaches 10 percent total impervious area – East Vashon (King County 2003). A total of approximately 1,460 acres within these four watersheds has been converted into impervious surfaces. The concentration of houses and roads near marine shorelines has resulted in a higher proportion of lands converted into impervious surfaces near the marine shorelines. Adjacent to the aquatic reserve, 16.9 percent of the lands within 200 feet of the marine shoreline are classified as impervious. It is generally recognized that ecological effects become severe as total impervious area approaches 30 percent in stream systems (Arnold and Gibbons 1996; Booth and Jackson 1997; Schueler 1994; Schueler and Holland 2000), but the impacts on marine systems are poorly understood.

Upland land use can be an indication to planners that potential threats and activities are occurring adjacent to the reserve. Approximately 43 percent of the land within 200 feet of the marine shorelines adjacent to the reserve is classified as either Urban/High Density (6 percent) or Mixed Urban/Low Density (37 percent) (King County 2002). The rest of the lands are classified as forested, shrub vegetation, or herbaceous vegetation. Washington DNR classified approximately 28 percent of the shorelines adjacent to the reserve as containing 'riparian vegetation' during the ShoreZone Inventory (Nearshore Habitat Program 2001). These data suggest that urban land pressures are present adjacent to this aquatic reserve and have affected between 43 and 72 percent of the shoreline habitats. Due to the concentration of activities near the marine shoreline these developments may be adversely impacting habitats and natural ecological processes that support the local aquatic ecosystem.

## 3.3 Submerged Aquatic Vegetation

The euphotic zone is the uppermost portion of the water column where light levels are high enough for photosynthesis to occur. Overall light transmission rates are affected by latitude, seasons, water quality, and suspended particulate matter (i.e., sediments and phytoplankton). In nutrient rich areas, the depth of the euphotic zone decreases as the incidence of algal blooms increases.

Within Puget Sound, nearshore ecosystem boundaries are generally defined by the depths at which aquatic vegetation can, or does, occur (Battelle 2003), although substrate and water current are also factors for vegetative growth. As a result, in some regional literature the outer limit of the nearshore and euphotic zones are defined similarly and placed at approximatly minus 66 feet (- 20 meters) below mean low low water (MLLW) (Williams et al. 2001).

Although there is no data regarding the historic depth of the euphotic zone within the reserve, work done between 2000 and 2002 can be used to establish a baseline for the euphotic zone and the extent of the nearshore. The DNR's Nearshore Habitat Program documented the mean eelgrass depths at five monitoring sites around Vashon and Maury Island to range from 0.0 feet MLLW to minus 17.4 feet (- 5.3 meters) MLLW (Berry et al. 2003). Battelle utilized compensation depths[1] for eelgrass, diatoms, and phytoplankton to estimate a maximum euphotic zone off the eastern shore of Maury Island at minus 46.9 feet

[1] Compensation depth is the depth at which photosynthesis produces oxygen at the same rate it is consumed by decomposition (Reid and Wood 1976).

(- 14.3 meters) extreme low low water (ELLW) (Battelle 2003). No data exists for Quartermaster Harbor.

*Eelgrass (Zostera marina)*
Eelgrass is a subtidal grass that spreads by rhizomes and prefers sandy/silt substrates. It can be found as individual plants, small patches, or large meadows in the low intertidal and shallow subtidal zones. Central Puget Sound eelgrass beds have been found at depths ranging from an extreme minimum depth of +5.25 feet (1.6 meters) and an extreme maximum depth of –24 feet (7.3 meters) relative to MLLW (DNR 2003). The primary factor controlling distribution at the upper boundary is desiccation stress, and at the lower boundary is light penetration (Thom et al. 1998). Similar to terrestrial grasses, eelgrass meadows are most dense in the spring and summer, going dormant and decaying during the fall and winter. In addition to protecting shorelines from wave and current driven erosion, eelgrass roots help anchor sediments and keep shallow subtidal environments moist and cool during low tides. Eelgrass is a key element in Puget Sound food webs and supports a variety of organisms, including zooplankton, juvenile salmonids, small crabs (such as the spider crab, nudibranch, larval forage fish (e.g., herring)), and a variety of small fish such as pipefish and gunnels.

Shoreline surveys found continuous or patchy eelgrass beds offshore of 78 percent (18.65 of 23.88 miles) of the shoreline within the aquatic reserve. Eelgrass observations in Quartermaster Harbor suggest that while the abundance of eelgrass may have changed within or between beds, the distribution of eelgrass has changed little over the past thirty years (WDFW, unpublished data). There are significant eelgrass beds scattered throughout the Maury Islands site, both within Quartermaster Harbor and along the eastern shore of Maury Island, making it an important area for salmonids, forage fish, and a variety of piscivorous birds and mammals (Appendix H).

*Kelp (sp.)*
Kelp is a common macroalgae that occurs in water depths of 50 to 100 feet (15 to 30 meters) at various locations within the Maury Island site. Unlike eelgrass, which actually roots in the sediments, kelp is held in place by structures called holdfasts that anchor the algae to rocky substrates (Nybakken 1997). Similar to eelgrass, kelp serves to decrease erosion impacts from waves and currents on nearshore environments. Growth rates for kelp can exceed 2.4 inches (6.0 centimeters) a day and at maturity, individual kelp may be 65 to 100 feet (20 to 30 meters) in length. Kelp is an important component of nearshore primary production rates (Nybakken 1997) and in Puget Sound it provides important habitat for a number of grazers (e.g., snails and sea urchins), filter feeders (e.g., anemones), scavengers (e.g., crabs), predators (e.g., rockfish, starfish, and salmonids), as well as a variety of smaller algae. Bladder kelp forests are located in areas where the seafloor is covered by rocky outcrops and boulders near the mouth of Quartermaster Harbor, south of Rosehilla and northeast of Neill Point (Blau 1975). There is no evidence of continuous kelp beds within the proposed reserve, but patchy distributions have been reported along the western and eastern shorelines of Maury Island (Appendix F).

# 4.0 Wildlife

A species list of fish and wildlife that has been documented to utilize the reserve area and vicinity is included in this attachment.

## 4.1 Fish

A large diversity of recreationally and commercially important fish species visit and spawn within the aquatic reserve (Miller and Borton 1980). However, it is important to note that most of these fish species do not occur continuously, or even frequently within the reserve (Blau 1975). Quartermaster Harbor has supported a limited commercial fishery for Pacific herring (*Clupea harengus pallasi*), pile perch (*Rhacochilus vacca*), and surf smelt (*Hypomesus pretiousus pretiosus*) (NORTEC 1984). While these fisheries appear to have declined from their historic highs, commercial fishing still occurs in the vicinity of Quartermaster Harbor. Records indicate that the largest pile perch (3 pounds, 9 ounces) and striped surfperch (2 pounds, 1 ounce) caught in Washington State were caught in Quartermaster Harbor in 1980 and 1981 respectively.

### 4.1.1 Salmonids

Adult and juvenile salmonids, particularly Chinook, chum, and the anadromous form of cutthroat and rainbow trout, have all been documented as occurring in, and dependent upon areas within the Maury Island site. The nearshore environment is also vital to the plant and animal communities upon which salmonids depend. While salmonids exhibit a wide range of specific life histories, there are several requirements that are common to all salmon and trout.

Although anadromous Pacific Northwest salmonids spend the majority of their life maturing in the open ocean, estuaries (such as Puget Sound) and freshwater systems are critical for adults and juveniles. Spawning adults utilize cold water streams and rivers (7 to 18 degrees Celsius) with substrates comprised of loose, silt-free gravel for redds. Substrate size is important not just for spawning, but as shelter for fry and as a diverse source of food from aquatic invertebrates. Spawning substrates generally range from about one inch in diameter up to about six inches in diameter (Raleigh et al. 1986). Complex, meandering channels provide a network of riffles, pools, and side channels for shelter and rearing. Juveniles are dependent upon native riparian vegetation for shading and cooler water temperatures, as well as a source of food from terrestrial insects, and shelter under/in large woody debris. Stable flows and high dissolved oxygen content ($\geq$ 7.0 mg/L) are also critical for the survival of both returning adults and rearing juveniles.

There are four diverse life histories among salmonids - adfluvial (spawn in streams, rear and mature in lakes); fluvial (spawn in natal streams but migrate to larger rivers for rearing and maturation); resident (remain in natal stream through all life stages); and anadromous (spawn and rear in streams, rear and mature in saltwater). The majority of Puget Sound salmonids exhibit the anadromous life history pattern (Wydoski and Whitney 2003). In addition to this variation in life history, salmonids also display a great deal of diversity in terms of juvenile freshwater residency and age at sexual maturity. Juvenile freshwater residency can range from a few weeks up to several years, while the age at sexual maturity generally ranges from about two to six years (Wydoski and Whitney 2003).

*Chinook Salmon (Oncorhynchus tshawytscha)*
Chinook, or king salmon, are anadromous and the largest of the Pacific salmon species (Myers et al. 1998). The species' eastern historic range extends from the California to Alaska, and from northeastern Asia to northern Russia (Healey 1991). The Puget Sound Chinook evolutionarily significant unit (ESU) was listed as threatened under the federal Endangered Species Act (ESA) by the National Oceanographic and Atmospheric Administration – Fisheries (NOAA – Fisheries) in March of 1999. The listing includes runs from the North Fork Nooksack River in northeast Puget Sound to the southern Puget Sound watersheds, Hood Canal, and the Strait of Juan de Fuca.

Chinook salmon display two distinct races (ocean and stream-type), with ocean-type fish spending a lesser amount of time in freshwater (Myers et al. 1998). Generally, ocean-type Chinook juveniles outmigrate either as fry during their first spring or fall, or as yearling juveniles during their second spring depending on environmental conditions and local adaptations. Stream-types spend one to two years in freshwater (NMFS 2003). Ocean-type Chinook also tend to remain nearer the coastline throughout their marine residence, with return timing varying from spring to winter depending upon local adaptations, but most fish return during the fall. Stream-type Chinook exhibit extensive off-shore ocean migration and usually return to freshwater they spawn in early fall-but enter freshwater early in spring or summer (NMFS 2003; Myers et al. 1998).

The Puget Sound Chinook salmon ESU is thought to be primarily comprised of ocean-type fish displaying a fall run timing. Fall run Puget Sound Chinook normally return to freshwater in July and August and spawn from September through January, while spring Chinook return to freshwater in April and May and spawn from August through September (Myers et al. 1998). Chinook spawning can occur in streams as small as seven feet wide, although they generally prefer to spawn in larger mainstem habitats. Spring Chinook spawn in middle and upper mainstem reaches, while fall run fish tend to spawn in lower mainstem areas (Cramer et al. 1999).

Both spring and fall run Chinook fry emerge from the gravel during February and March, with the majority of the fall run progeny outmigrating within 60 to 150 days after emergence (Cramer et al. 1999). Chinook fry prefer the lower velocity margins of streams, with fall Chinook moving steadily downstream to the estuary, where they normally spend several months rearing. Streamside and marine riparian habitat provides important cover in the form of wood, root wads, overhanging vegetation, and undercut banks (Healey 1991).

After moving into salt water, Puget Sound Chinook generally migrate north along the Canadian coast, but some fall Chinook spend their entire marine residence within

Puget Sound. Ocean-type Chinook generally remain at sea from one to six years before they mature, with most spending two to four years in the ocean before returning to their natal streams to spawn (Wydoski and Whitney 2003).

Myers et al. (1998) estimated an approximate run size of 690,000 Chinook in Puget Sound at the beginning of the 20th century[2] when hatchery production was negligible. This compares to a recent average run size of approximately 240,000, the majority of which is from hatchery production. An estimated two billion hatchery Chinook have been released into Puget Sound tributaries since the 1950s (Myers et al. 1998) and hatchery returns account for approximately 57 percent of the total spawning escapement (NMFS 2003).

Sampling has documented juvenile Chinook salmon along the shorelines of Maury Island and within Quartermaster Harbor. Coded-wire tag data from these samples suggest that fish found in this area arise from one of several watersheds with Chinook salmon caught from the following hatcheries: Wallace River Hatchery (WRIA 7), Soos Creek Hatchery (WRIA 9), White River Hatchery (WRIA 10), Hupp Springs and Rearing facility (WRIA 15) (Brennan and Higgins 2004). The presence of Chinook salmon from a number of different areas rearing along the shorelines of Vashon and Maury Islands suggest that that juvenile Chinook readily cross open water to reach the island.

While there are suggestions that Chinook may have been observed in the lower reaches of Judd Creek, Brennan and Higgins (2004) suggest that there are no Chinook producing streams or hatchery releases of Chinook on Vashon or Maury islands. Juvenile and adult Chinook have been documented as using the shallow water habitats of Quartermaster Harbor for rearing. These fish prey on the forage fish that inhabit Quartermaster Harbor and the surrounding areas. The eastern shoreline of Maury Island is also an important migration corridor, as Chinook smolts tend to remain in the nearshore environment as they migrate out of the Puget Sound. Brennan and Higgins (2004) found that vegetated shoreline habitats are an important food source for juvenile chinook salmon with juvenile diets numerically dominated by insects characteristic of terrestrial vegetated habitats such as Psocoptera (bark lice), Homoptera (aphids, plant hoppers), and Hymenoptera (ants).

*Puget Sound Chum Salmon (Oncorhynchus keta)*

The majority of chum stocks in the Puget Sound are fall runs, although summer and winter stocks also exist. In 1993, the Washington Department of Fisheries identified forty-five fall chum populations in Puget Sound, including nine in the northern area (Canada-Washington border to the Stillaguamish River), 30 in the southern area (Snohomish River watershed south and Hood Canal), and six in the Strait of Juan de

[2] This estimate, as with other historical estimates, should be viewed with caution. Fish landings used in this calculation included a portion of fish landed at Puget Sound ports but originating in Canada and other areas outside Puget Sound, and the estimates of exploitation rates used in run-size expansion calculations may not be based on precise data (Myers et al. 1998).

Fuca (Washington Department of Fisheries et al. 1993). The status was *unknown* for 13 of these populations and *healthy* for all others. Hood Canal populations of summer chum were listed as threatened in 1999 under the federal ESA by the NOAA – Fisheries.

Although fall chum runs fluctuated between roughly 156,000 to more than 2.4 million fish from 1968 to 1999, the average runs for the period were between one and almost 1.5 million fish. Unlike other salmonid stocks, chum populations have exhibited a positive trend since the late 1960s. Approximately 37 percent of the total Puget Sound run originates in the Hood Canal, 33 percent in South Puget Sound, 29 percent in North Puget Sound, and just one percent in the Strait of Juan de Fuca (WDFW 2003a).

Chum are anadromous and generally mature between three and five years of age, with a high proportion of Washington stocks maturing at age three. Spawning of fall chum primarily occurs from October through January, while winter chum generally spawn from mid-December through early March (Johnson et al. 1997).
Young of year emerge between February and June and migrate quickly to the estuary where they rear for several months before migrating out of the Puget Sound. Eelgrass beds are extremely important for rearing chum salmon, with two species of copepods that make up a large portion of juvenile's diets found only in eelgrass (Simenstad et al. 1988). Upon leaving Puget Sound, Washington chum generally migrate northward along the coast with their path being closer to shore than coho, Chinook, or steelhead. Chum rear at sea for two to four years before returning to their natal streams to spawn.

From 1991 through 2000, an average of more than 5.1 million hatchery chum salmon per year were released into Puget Sound. Of these, approximately 91 percent were fall chum and one percent were winter chum (Pacific States Marine Fisheries Commission 2002).

While there is no data regarding total abundance of chum at the Maury Island site, both juveniles and adults have been documented in the area. In addition to juveniles using the nearshore for rearing habitat, the WDFW Spawning Ground Survey Database indicates that fall chum spawn in the lower reaches of Judd Creek (Kerwin and Nelson 2000). It is not known whether these fish originated from Judd Creek, or whether they are the progeny of strays from other systems or hatchery plants.

*Puget Sound Coho Salmon (Oncorhynchus kisutch)*
Coho salmon were historically distributed along the Pacific coast from Mexico to Alaska and from Russia to Japan (Scott and Crossman 1973). NOAA – Fisheries, designated the Puget Sound coho salmon ESU as an ESA candidate species in 1995.

Most coho in Washington, Oregon, and California spend the first year of their lives in freshwater and return to spawn in their third year, although some precocious males return to spawn at age two (Wydoski and Whitney 2003). The Puget Sound spawning migration begins in August, with spawning generally occurring from September through January (Weitkamp et al. 1995). Wild coho tend to spawn in smaller rivers and tributaries or side channels of larger systems, with fry emerging within six to eight weeks (Wydoski and Whitney 2003).

Weitkamp et al. (1995) noted that while populations of the Puget Sound coho ESU are abundant and that runs and natural spawning escapements are generally stable, there are substantial risks to the remaining native stocks. Although coho are remarkably adaptable and can be found spawning in significantly degraded streams, wild populations continue to decline as a result of habitat loss from human development (Wydoski and Whitney 2003).

Presently, most coho returning to Puget Sound streams are hatchery produced. From 1991 through 2000, approximately 24 million hatchery juvenile coho were released into Puget Sound each year. Over this period, total releases decreased from about 40 million in 1991 to less than 10 million in 2000 (Pacific States Marine Fisheries Commission 2002).[3]

Coho salmon occur in both Judd and Fisher creeks, however there is no information regarding the overall abundance of coho in the Vashon-Maury island area. Hatchery and wild coho smolts feed along the shorelines of Vashon and Maury Islands between May and September of each year with most activity in May and June. Juvenile coho captured within the reserve were found to be from wild stocks, Wallace River Hatchery (WRIA 7), Soos Creek Hatchery (WRIA 9), or Voights Creek Hatchery (WRIA 10). Juvenile coho caught along marine shorelines in King County appear to feed mainly on zooplankton before switching to fish at larger sizes (Brennan and Higgins 2004).

*Coastal Cutthroat Trout (Oncorhynchus clarki clarki)*
Coastal cutthroat trout exhibit all four salmonid life histories - adfluvial, fluvial, resident, and anadromous (Wydoski and Whitney 2003). Different individuals from the same population can exhibit different life history patterns. Cutthroat trout are capable of repeat spawning and some individuals have been noted to spawn each year for as many as six years.

Anadromous, or sea-run, coastal cutthroat from smaller systems such as the streams on Vashon-Maury Island generally return to freshwater from December through March and spawn from February through late April. Cutthroat fry emerge from March through June, with a peak in mid-April. Anadromous forms of cutthroat rear in freshwater for one to six years before migrating to sea. Outmigration occurs from March through June, with a peak in mid-May.

[3] Data may be incomplete for 2000. Releases in 1999 were about 12 million.

Cutthroat are known to rear extensively in estuarine and nearshore habitats and many do not venture far from their natal streams. In general, sea-run cutthroat do not make long ocean migrations and they rarely overwinter at sea, instead returning to nearby streams to spend the winter.

Nonmigratory coastal cutthroat include fish generally found in small streams and headwater tributaries near spawning and rearing sites. They typically grow more slowly than the other life history forms of cutthroat, are smaller when they reach maturity, and normally do not live longer than two to three years.

Several streams on Vashon and Maury Islands have been documented to support cutthroat trout including Judd, Fisher, Shawnee, Tahlequah, and Mileta creeks (King County 2000). An impassible barrier in the form of a culvert precludes anadromous forms of cutthroat from inhabiting Shawnee Creek. Both resident and sea-run cutthroat are thought to inhabit Mileta, Judd, and Fisher creeks (EVS 2000). Cutthroat trout of all age classes are thought to use Quartermaster Harbor as a rearing area.

*Puget Sound Steelhead (Oncorhynchus mykiss)*
Like cutthroat, rainbow trout exhibit great diversity in their life history patterns and are capable of repeated spawning across years. The anadromous form of rainbow trout, referred to as steelhead, can be divided into summer (stream-type) or winter (ocean-type) stocks. In Puget Sound the majority of steelhead populations are winter-run, meaning adults normally return to freshwater from November to December, and the peak of spawning occurs between March and May of the following year (Busby et al. 1997).

Steelhead eggs incubate for approximately four to seven weeks, with fry emerging from June through mid-August. After hatching, steelhead typically spend from two to four years in their natal stream before migrating to sea, with smolts outmigrating from April to June. Steelhead trout are thought to move more directly out to sea than other salmonids, although some steelhead rear for short periods in estuarine environments. They spend up to three years in the ocean before returning to spawn and typically live from six to eight years (Wydoski and Whitney 2003).

Total runs for Puget Sound steelhead in the early 1980s were estimated by Light (1987) as approximately 100,000 winter steelhead and 20,000 summer steelhead. Light provided no estimate of hatchery proportions for specific streams, but for Puget Sound and coastal Washington combined, he estimated that 70 percent of steelhead in ocean runs were of hatchery origin.

The only stream in the Maury Island area known to support steelhead is Judd Creek, but it is not known if the population is self sustaining or whether they are strays from other Puget Sound systems (Kerwin and Nelson 2000). There is no data pertaining to the abundance of steelhead in Judd Creek.

*Bull Trout/Dolly Varden (Salvelinus confluentus)*
Puget Sound and Washington coastal bull trout populations were listed as threatened in November 1999 by the U.S. Fish and Wildlife Service (USFWS). Critical habitat for Puget Sound bull trout populations has yet to be designated.

Bull trout are a char species endemic to western North America that exhibits all four salmonid life history forms - resident, fluvial, adfluvial, and anadromous. They require colder water than most other Pacific salmonids (2 to 10 degrees Celsius), are heavily dependent on instream cover, and prefer low gradient stream reaches with clean, gravel substrates (Goetz 1989; WDFW 1998). These specific habitat requirements are normally found in more pristine environments, thus bull trout are quite vulnerable to habitat modifications.

The 1998 bull trout/Dolly Varden population inventory, conducted by WDFW, identified 80 distinct stocks in Washington State. All bull trout/Dolly Varden populations in Washington are maintained by wild production and of the populations identified, 18 percent are considered healthy, three percent depressed, eight percent critical, and the status of the remaining 58 stocks is unknown (WDFW 1998).

There are no bull trout found in the streams of Vashon or Maury Island, and Quartermaster Harbor is generally too warm to be utilized by rearing, anadromous bull trout. The eastern shoreline of Maury Island could be periodically inhabited by migrating anadromous bull trout, although no observations of the species in this area have been documented.

### 4.1.2 Forage Fish
The Maury Island site supports an abundance of forage fish stocks including Pacific herring, surf smelt, and sand lance.

*Pacific Herring (Clupea harengus)*
Pacific herring is a pelagic (lives in open sea) marine species that depends heavily upon the nearshore environment for spawning. Herring spawning grounds are well defined and stocks of the fish show strong fidelity to particular spawning areas. Herring spawning timing is also very specific, seldom varying more than seven days from year to year (WDFW 2000). Most Puget Sound herring spawn from mid-January through March. Herring utilize a variety of marine vegetation in the intertidal and shallow subtidal zones for spawning, primarily in semi-exposed and semi-protected areas. The substantial eelgrass beds and semi-protected environment of Quartermaster Harbor makes for an ideal spawning location (Appendix G). The Quartermaster Harbor herring stock is one of 18 in the Puget Sound. This stock is the largest spawning population in the southern/central Puget Sound and among the largest in the entire Puget Sound region. Surveys conducted from 1994 through 2003 found an average biomass of the Quartermaster Harbor herring stock of 1,123 short tons (Figure 1).

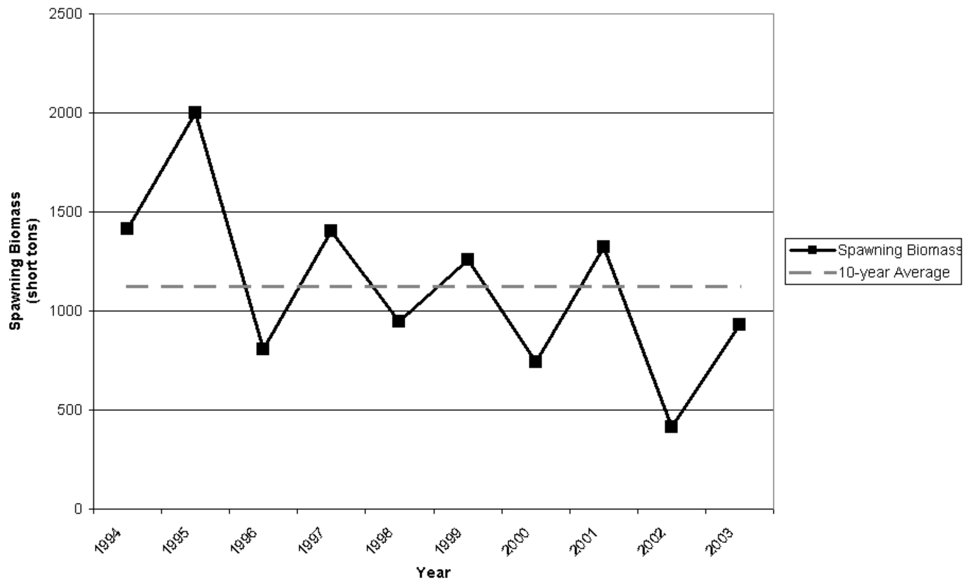


**Figure 1: Pacific herring biomass in Quartermaster Harbor (1994-2003). (Source: WDFW 2004).**

Herring spawning usually occurs from 0.0 to minus 10 feet (0.0 to 3 meters) in tidal elevation. The documented herring spawning area for the Quartermaster Harbor stock includes more than 962 acres of habitat (WDFW, unpublished data). While spawning has been documented throughout Quartermaster Harbor and along the eastern shore of Maury Island, spawning activity is variable and typically concentrated within this larger area. The eggs incubate for 10 to 14 days prior to hatching. Following hatching, the larvae drift in the currents. When they are approximately 25 to 40 mm in length, juvenile herring begin to form schools and remain in the nearshore environment until they migrate to the open ocean in early fall, although some herring spend their entire lives in the Puget Sound (McCrae 1994; WDFW 2000). Highly productive areas such as eelgrass beds are important habitats for herring of all age classes, which is another reason herring are rather abundant in Quartermaster Harbor. After reaching sexual maturity at age two to four, herring return to their natal spawning grounds. At maturity, herring can reach a maximum size of about 18 inches.

In addition to herring spawning sites along the shoreline of Quartermaster Harbor and the southeast shoreline of Maury Island, there are also two pre-spawning holding locations near Neill and Piner Points (Appendix G). Herring congregate in these deeper water areas prior to migrating to nearshore habitat to spawn.

Data suggests that sustained noise from large fishing vessels and/or small boats can cause avoidance and alarm responses in herring (Schwarz and Greer 1984). However, the data also suggest that herring may habituate to noise from smaller vessels. As a result, there may be different threat levels and threat sources within the reserve. Because most boats in Quartermaster Harbor are recreational vessels, herring may have habituated to the noise leaving damage to eelgrass spawning and rearing habitat as the primary threat to the species. In addition, we would not expect there to be intensive recreational boating activities during the spawning period. However, noise from large commercial tugboats and ships in and directly adjacent to spawning areas may be a significant threat to spawning herring, as well as in holding areas off Neill and Piner Points. WDFW has also reported chronic herring spawn mortality in the Dockton area, the cause of which is unknown.

*Surf Smelt (Hypomesus pretiosus)*
Surf smelt are an important food for salmonids, including federally listed Chinook salmon, birds, and other wildlife throughout Puget Sound. The reserve supports several documented spawning areas throughout Quartermaster Harbor, with additional spawning areas reported along the southeastern shoreline of Maury Island and near Point Robinson (Appendix G). These documented spawning beaches represent 5.71 miles of shoreline habitat. Spawning occurs throughout the year in extremely shallow water on mixed sand and pea gravel beaches that are kept moist from freshwater seeps (WDFW 1997). In Quartermaster Harbor most surf smelt spawning occurs between November through early January each year (Blau, 1975). The species is dependant on relatively undisturbed beaches, which makes surf smelt extremely vulnerable to shoreline modifications that alter substrate composition and destroy spawning habitat.

Surf smelt are a pelagic species, although many individuals remain in nearshore environments throughout the year. They feed on a variety of zooplankton and epibenthic organisms, including planktonic crustaceans and fish larvae. Spawning occurs during much of the year on mixed sand-gravel beaches at a tidal elevation between approximately plus 6.5 feet and the mean higher-high water line, or higher (Lemberg et al. 1997). Adults school offshore and may return to the same spawning ground each year. Surf smelt rarely reach greater than five years of age, with most spawning populations comprised of one and two-year-old fish (Lemberg et al. 1997).

*Sand Lance (Ammodytes hexapterus)*
Although sand lance are broadly distributed throughout Puget Sound, very little is known about their life history (WDFW 1997). These fish spawn in the upper intertidal zone of sand-gravel or sand beaches, normally higher than 3 feet (1.5 meters) in tidal elevation. Spawning occurs from November through February, with the eggs incubating for approximately thirty days before the larvae enter the nearshore environment.

There is only one documented area of sand lance spawning habitat representing approximately 0.3 miles of shoreline habitat within the reserve (Appendix G). Future surveys are needed to determine if this site represents the full extent of spawning activity within the reserve and to quantify spawning activity at this site. Like surf smelt, sand lance depend on sandy beaches and are therefore vulnerable to shoreline modification in the reserve. Sand lance are an important food source for salmonids, including federally listed Chinook salmon, and other marine aquatic species, as well as terrestrial wildlife.

### 4.1.3 Other Fishes

Several studies assessing the health of Commencement and Elliot bays have sampled Quartermaster Harbor to serve as control samples (e.g., Malins et al. 1997; Gibson et al. 2000). Compared to the urban bays, samples from Quartermaster Harbor contained a lower abundance of fish, however these samples contained significantly more species and more biomass (Gibson et al. 2000). Additionally, almost every fish species found in both the urban bays and Quartermaster Harbor were significantly larger within Quartermaster Harbor. These studies also identified sensitive species that are more common or significantly larger in the reference areas (Quartermaster Harbor) than in the urban bays. These species include: Spiny dogfish, spotted ratfish, longnose skate, rock sole, starry flounder, speckled sanddab, pile surfperch, striped surfperch, bay goby, blackbelly eelpout, bay pipefish, and plainfin midshipman (Gibson et al. 2000).

*Groundfish*

Groundfish is a broad term used for fish that spend all or significant portions of their lives on the sea bottom. They are a diverse group that includes species such as spiny dogfish (*Squalus acanthias*)*,* skates (*Raja sp.*), Pacific cod (*Gadus macrocephalus*), rockfish (*Sebastes sp.*), and lingcod (*Ophiodon elongatus*). Of the more than two hundred species classified as groundfish in Puget Sound, only twenty-one are actively managed as commercial or recreational fisheries (Palsson et al. 1998).

While predator-prey interactions are not well understood, groundfish are an important prey item for marine mammals and piscivorous birds. Groundfish are carnivorous, preying upon benthic and epibenthic macroinvertebrates such as shrimp and crabs, as well as small fish, and likely compete with salmon and other fish stocks for habitat and food. Although groundfish populations within Puget Sound are not always well documented, it is known that they are vulnerable to habitat destruction from fishing gear, as well as decreased recruitment from the harvest of large and sexually mature individuals and loss of kelp beds.

*Flatfish*

Most species of flatfish spawn during winter months on soft mud bottoms at depths of about minus 40 feet (12 meters) or greater. Fertilized eggs are pelagic and hatch within a few weeks, with the larvae slowly sinking as they mature. As juveniles, flatfish are physically similar to other round shaped fish, with a perpendicular orientation and a single eye on each side of their body. As the eye moves to a particular side, the fish swim oriented toward that side and eventually settle on the bottom in the nearshore. It is not until the fish reach adulthood, between two and four years of age, that they sever their relationship with the nearshore and move to deeper water. Flatfish can live as long as fifty years and reach sexual maturity at three to seven years of age.

In 2002, a WDFW bottom trawl of Quartermaster Harbor found a high diversity and concentration of flatfish including English sole (*Parophrys vetulus*), speckled sanddab (*Citharichthys stigmaeus*), Pacific sanddab (*Citharichthys sordidus*), and southern rock sole (*Lepidopsetta bilineata*) (W. Palsson, Research Scientists, Washington Department of Fish and Wildlife, personal communication, July 7, 2003).

*Rockfish (Sebastes sp.)*
Rockfish bear live young and release them into the environment as larvae. Although males transfer sperm to females in the fall, actual fertilization can be delayed by as much as two to four months. Depending on species and size, each female releases between 200,000 and 800,000 larvae from January through May. Larvae are planktonic, floating near the surface and serving as a food supply for plankton eating animals. After a few months, the juveniles begin to inhabit their preferred habitat of kelp forests and rocky reefs.

Fishing has taken a significant toll on rockfish numbers and reproductive success. Since the 1970s, recreational catches have declined by 50 to 60 percent (Puget Sound Water Quality Action Team 2002), with fishers targeting larger individuals. As rockfish are long-lived species (55 years or greater) and does not reach sexual maturity until 10 years of age or greater, the loss of larger fish may also be having a negative impact on recruitment. The Puget Sound Water Quality Action Team (2002) estimates that rockfish spawning potential has declined 75 percent since the 1970s.

The eastern shore of Maury Island has several rocky reefs and submerged wrecks that are capable of supporting rockfish. Divers from WDFW have documented the presence of several species including lingcod *(Ophiodon anadensi)*, copper *(Sebastes caurinus)* and brown *(Sebastes auriculatus)* rockfishes, as well as red Irish lord *(Hemilepidotus hemilepidotus)* (W. Palsson, Research Scientists, Washington Department of Fish and Wildlife, personal communication, July 7, 2003).

## 4.2 Birds

The reserve area offers wetland and riparian habitat for several species of migratory and resident marine birds. WDFW winter surveys between 1993 and 2002 identify American widgeon, surf and white-winged scoters, common and barrow’s goldeneye, bufflehead, gulls and western grebes as the most common wintering marine birds (WDFW, unpublished data). Average and peak observations for common bird species are shown in Table 1. Common resident birds include glaucous-winged gulls, black brant and the great blue heron (NORTEC 1984). Aside from specific areas with substantial human development (i.e., Gold Beach, Sandy Shores, Dockton, and Burton), the areas adjacent to the Maury Island site has riparian habitat that is largely intact and supports a number of bird populations, both seasonal and resident. In addition to being sheltered and relatively undisturbed by boat traffic, the site offers a plentiful food supply for aquatic piscivorous birds in the form of forage fish, juvenile salmonids, and shellfish.

**Table 1: Average and peak observations for wintering marine birds within the Maury Island site (WDFW, unpublished data)**

| Species | Average annual count (1992 – 2001) | Peak 1-day Count | Date of Peak Count |
|---|---|---|---|
| American Widgeon | 152.1 | 403 | 12/08/1999 |
| Bufflehead | 103.8 | 144 | 12/11/2000 |
| Barrow's Goldeneye | 36.9 | 116 | 12/10/2001 |
| Common Goldeneye | 41.3 | 99 | 12/11/1992 |
| Unidentified Goldeneye Sp. | 144.6 | 314 | 12/28/1995 |
| Surf Scoter | 267 | 698 | 12/11/1992 |
| White-winged Scoter | 119.1 | 294 | 12/11/1992 |
| Unidentified Scoter Sp. | 715.2 | 1218 | 12/28/1995 |
| Western Grebe | 602.6 | 1664 | 12/18/1996 |
| Gull (all species) | 252.4 | 409 | 1/04/1995 |

Quartermaster Harbor has been designated an important bird area (IBA) by the Audubon Society of Washington and supports approximately 8 percent of Washington's wintering population of Western grebe (Cullinan 2001). In addition to grebe, the area provides winter refuge for approximately 3,000 individuals from 35 species of aquatic birds annually (Cullinan 2001). The IBA program has two primary goals: 1) to identify the sites in the state of Washington that are the most essential for long-term conservation of birds, and 2) to take action to ensure the conservation of these sites.

*Western Grebe (Aechmophorus occidentalis)*
The western grebe is considered by WDFW to be a candidate species for inclusion on the state species of concern list (Table 2). Grebes prefer to winter in sheltered, ice-free waters with large supplies of forage fish, which makes Quartermaster Harbor ideal habitat. Although almost 100 percent of the bird's diet is fish, they also eat crustaceans, worms, and insects, spearing their prey with their long, pointed bills. Adult birds range from 22 to 30 inches in length and have long necks, with their feet positioned at the far back of the body, making walking difficult (Pease 2000). The birds migrate north beginning in late April and return to the site during September and October (Kirschenbaum 1996).

The presence of a relatively large population of wintering western grebe in Quartermaster Harbor was the primary reason that Audubon Washington listed the area as an IBA. From 1989 through 1991, surveys found an average winter abundance of 1,435 grebes in the area. Additional surveys conducted from 1999 through 2002 observed an average total of 2,345 individuals in the area during winter months (Willsie 2003). Annual winter flyover surveys from 1992 to 2001 detected an average of 603 grebes per survey year with a peak one-day count of 1664 western grebes in 1996 (WDFW, unpublished data). These surveys illustrate that Quartermaster Harbor area is regularly used by large numbers of wintering western grebes.

**Table 2: Bird species of concern present at the Maury Island site.**

| Common Name | Scientific Name | Federal Listing Status | State Listing Status |
|---|---|---|---|
| Western grebe | *Aechmophorus occidentalis* | None | Candidate |
| Bald eagle | *Haliaeetus leucocephalus* | Threatened | Threatened |
| Marbled murrelet | *Brachyramphus marmoratus* | Threatened | Threatened |
| Harlequin duck | *Histrionicus histrionicus* | Species of Concern | None |
| Common loon | *Gavia immer* | None | Sensitive |
| Brandt's cormorant | *Phalacrocorax penicillatus* | None | Candidate |
| Common murre | *Uria aalge* | None | Candidate |
| Great blue heron | *Ardea herodias* | None | Monitor |
| Red-necked grebe | *Podiceps grisegena* | None | Monitor |
| Horned grebe | *Podiceps auritus* | None | Monitor |
| Source: Willsie 2003; WDFW 2003c | | | |

*Great Blue Heron (Ardea herodias)*
The great blue heron is a rather large bird attaining lengths of between 42 and 52 inches. They have long and slender bills, necks, and legs and they fly with a distinctively folded back neck. The great blue heron feeds in shallow waters, standing along the margin and using their long bills like tongs to clamp their prey. They tend to congregate near areas with eelgrass to take advantage of the abundance of forage fish (Quinn and Milner 1999). They are communal nesters that utilize rather tall trees, normally at least 30 feet in height, adjacent to feeding areas. Due to their dependence on nesting trees, the species is sensitive to riparian vegetation clearing, particularly near eelgrass beds.

The Mileta Creek Wildlife Refuge recently supported one of the largest Great Blue Heron rookeries in King County, located on the eastern shore of Quartermaster Harbor. Recent anecdotal reports suggest that this rookery may have been abandoned.

While currently not included on the state list of species of concern, WDFW has noted an apparent decline in the species and is monitoring populations (Table 2). Although there are little data pertaining to the abundance of great blue herons in this area, surveys conducted in Quartermaster Harbor from 1999 through 2001 noted an average of six individuals (Willsie 2003).

*Bald Eagle (Haliaeetus leucocephalus)*
Bald eagles were first protected by the Bald Eagle Protection Act of 1940 and later listed as endangered under ESA. In 1978, the bald eagle was reclassified as threatened in five states, including Washington. Bald eagles are also listed as a threatened species on the Washington State species of concern list (Table 2). In the past 20 years, the population of

nesting bald eagles has grown about 10 percent per year as eagles reoccupy habitat (Stinson et al. 2001). Recovery is especially dramatic in Washington State, where there are now over 600 nesting pairs, with approximately 300 pairs in Puget Sound alone. Due to the demonstrated recovery of the species, in 1999 the USFWS proposed to remove bald eagles from the list of threatened and endangered species (64 FR 36454). To date, no decision has been made regarding the proposed delisting.

Bald eagles are found wherever food (i.e., fish and waterfowl) is abundant, with nesting typically occurring in forested settings that are relatively free from human disturbance (Stalmaster 1987). Nesting pairs return to the same nesting territories year after year, while wintering groups tend to be more transitory. In Puget Sound, the seasonal home range containing the foraging and nesting habitat of an eagle pair averages about 2.6 square miles (Stinson et al. 2001). Territories usually include large bodies of water, as the species tends to prefer fish to all other types of prey, although they may also feed on small mammals and waterfowl (Stalmaster 1987). Bald eagles are opportunistic feeders and forage most intensively at first daylight and at low tide (Watson et al. 1991). In the Puget Sound, nest initiation begins sometime in February and the breeding cycle ends when the juveniles disperse near the end of August (Stalmaster 1987).

There is one bald eagle nesting area near the Maury Island site and more than 10 additional nests in the local vicinity. The one nest closest to the reserve boundary is near Neill Point. Bald eagle feeding areas extend along the southern shore of Vashon Island into Quartermaster Harbor and along the southern shoreline of Maury Island (Appendix H). There is little information regarding the abundance of bald eagles using the Maury Island site, although surveys conducted from 1999 through 2001 noted an average of four individuals.

*Marbled Murrelet (Brachyramphus marmoratus)*
Marbled murrelets in Washington, Oregon, and California were listed as a threatened species under the federal Endangered Species Act in 1992 and are also listed as a threatened species on the Washington State species of concern list (Table 2). Classified as diving seabirds, murrelets are small (0.5 pounds) birds. The species primarily feeds on small fish such as sand lance, smelt, and herring, which makes Quartermaster Harbor a suitable location for these birds. They are normally found in small groups of two to 12, although they may form larger groups in abundant feeding areas. They spend the majority of their lives within approximately one mile of the coastline, although they nest up to about 45 miles inland in old growth trees.

There have been reported, although unconfirmed, sightings of marbled murrelets in the vicinity of Point Robinson. There is no information regarding abundance or frequency of use of the species in this area and the Maury Island site is not within the species designated critical habitat.

*Other Bird Species*
In addition to the species described above, there are a number of other species of grebes, cormorants, ducks, swans, geese, gulls, and loons in the area, some of which are included on the Washington State species of concern list (Table 2). Waterfowl such as mallard, scoters, goldeneye, and bufflehead tend to be the most common bird species in the area.

## 4.3 Marine Mammals
Both resident and transient species of marine or marine oriented mammals are found in the vicinity of Vashon and Maury Islands throughout the year.

*River Otter (Lontra anadensis)*
Rivers otters are fairly common throughout Puget Sound and are likely to occur within the Maury Island site. Although river otters hunt and den on land, they also rely heavily on a diet of fish and shellfish and can be expected to feed in the shallow inter- and sub-tidal areas throughout the Vashon and Maury Island areas, as well as at small estuaries such as the mouth of Judd Creek. They require deep and fairly clean water to remain healthy, and their position near the top of the aquatic food web makes them extremely susceptible to bioaccumulation of contaminants such as mercury, PCBs, Dichloro Diphenyl Trichloroethane (DDT), dieldrin, and other pesticides.

Females reach sexual maturity at about two years of age, while males are mature at about five years. Breeding occurs in late winter to early spring, and litters of between one and four are born within nine to twelve months. Pups are weaned within four months, but spend several months with their mothers learning to hunt. Otters can live as long as 13 years in the wild and have few natural predators that would occur within the Maury Island site.

*Harbor Seals (Phoca vitulina)*
Harbor seals are rather common throughout the Central Puget Sound area and may be present, periodically, at the Maury Island site. They reach about four to six feet in length and weigh between 176 and 300 pounds. They tend to favor nearshore coastal waters and are often seen at sandy beaches, mudflats, bays, and estuaries. They spend about half their time on land and half in water, and they sometimes sleep in water. They are opportunistic feeders, eating herring, sole, sculpin, flounder, salmonids, and other available fish (Marine Mammal Center 2000). There are no harbor seal haul-out sites in the vicinity of the Maury Island site and abundance of the species in the area is not known.

*California Sea Lion (Zalophus californianus )*
California sea lions are occasionally observed resting on buoy markers “TC” off southeastern Maury Island and “TB” off Point Robinson. They are extremely social creatures and hunt throughout the day and night, feeding on salmon, octopus, and other pelagic fish. Their sizes vary with gender and age. Females weigh about 200 pounds at maturity, whereas males weigh about 600 pounds or greater.

*Killer Whale (Orcinus orca)*

The Puget Sound Orca population is listed as endangered by WDFW and a review of its listing under the federal Endangered Species Act was ordered in late fall of 2003. Killer whales frequent a variety of marine habitats with adequate prey resources and do not appear to be constrained by water depth, temperature, or salinity (Baird 2000). During early autumn, southern resident pods expand their routine movements to include Puget Sound in addition to Georgia Strait, San Juan Islands, and Strait of Juan de Fuca. During this annual range expansion Orcas are regularly observed in the vicinity of this aquatic reserve and may occasionally feed along the outer shoreline of Vashon and Maury Islands, and less frequently, may enter Quartermaster Harbor. This activity is believed to be in response to chum and Chinook salmon runs (Osborne 1999). Similarly to otter and sea lions, Orca are top predators and extremely susceptible to bioaccumulation of toxins in the food web.

### 4.4 Invertebrates

In addition to geoduck, species documented within the Maury Island site include: barnacles; mussels; nudibranch; hairy shore crab; heart cockle; chiton; cockle; Dungeness crab; flat worm; tube worm; red rock crab; sand dollar, sea anemone; sea star; sea urchin, and shrimp (Bloch et al. 2002). More than 80 percent of the infaunal bivalves in Quartermaster Harbor are suspension feeders and Manilla clams (*Tapes philippinarum*), bent-nosed clams (*Macoma inquinata*), and macoma clams (*Macoma balthica*) were the most common species comprising 75 percent, 11 percent, and 5 percent of observations (Landahl 1985). Compared to urban bays, samples from Quartermaster Harbor contain larger abundances or sizes of 'sensitive species' including sea cucumbers (*Cucumaria miniata*), spotted sea cucumber (*Cucumaria piperata*), crescent sea cumber (*Pentamera populifera*), edible sea cucumber (*Parastichopus californica*), sunstars (*Solaster stimpsoni*), hermit crabs (*Pagurus spp*.) and snails (*Nassarius mendicus*) (Gibson et al. 2000). A 2002 WDFW bottom trawl in Quartermaster Harbor revealed a high abundance of macroinvertebrates including Dungeness crab, red rock crab, red sea cucumber, and sea stars.

*Geoduck (Panopea abrupta)*

Geoduck clams are found from California to Alaska, although they are most abundant in the Puget Sound and coastal waters of British Columbia. Geoducks are found from the low intertidal zone to at least 360 feet (110 meters) in water depth and are most abundant in sand and silt substrates. The species is the largest of the burrowing clams, and grows rapidly with individuals in Puget Sound averaging 1.5 pounds within four or five years. They attain their maximum size and weight of approximately two pounds within 15 to 25 years (Hoffmann et al. 2000). Geoducks are very long-lived with some individuals reaching ages of over 130 years, with an average age at commercial tracts of about 46 years (Bradbury et al. 2000). Average density in the south and central areas of Puget Sound is approximately 0.18 geoducks/ft$^2$ (1.9 geoducks/m$^2$) (Goodwin and Pease 1991).

There are five commercial geoduck tracts located at the Maury Island site. Harvest tract #10300 (62 acres) along the western shoreline of Quartermaster Harbor is currently unavailable for commercial harvest due to pollution concerns associated with failing septic systems in the vicinity (Sizemore and Ulrich 2002) (Appendix I).

The other five geoduck tracts include more than 433 acres and 6.6 million pounds of geoducks (Sizemore and Ulrich 2002). The state is not harvesting at these locations, nor is there any plan to do so in the immediate future. The Puyallup tribe is harvesting at the Maury Island site along the eastern shoreline of Maury Island (harvest tract 10150) (Appendix I). Tract #10150 includes 130 acres along the entire eastern shoreline of Maury Island, with an estimated population of 1,371,000 geoducks weighing a total of about 3,702,000 pounds. Harvest in this area is restricted from January 1 through April 15 to areas deeper than minus 35 feet (10 meters) MLLW to protect herring spawning. There is also a recommended harvest boundary of minus 25 feet (7 meters) MLLW or deeper from April 16 through December 31 to protect herring habitat (WDFW 2003b). In 2002, tribal harvest took approximately 142,086 pounds of geoducks from the southern portion of this tract.

In recent years, the Puyallup tribe also conducted geoduck harvest with tract #10100, along the northern shoreline of Maury Island (Appendix I). This tract is comprised of 43 acres and is estimated to currently support approximately 124,000 geoducks with a total biomass of about 334,000 pounds. Tribal harvest through 2002 accounted for a removal of approximately 423,950 pounds of geoducks (WDFW 2003b). The Puyallup tribe now believes that the tract has been depleted to the point that commercial harvest is not economically feasible and the tract is in recovery, although the post-harvest survey has not been completed. The time required for recovery of a commercial geoduck tract generally averages about 40 years in Puget Sound.

To protect eelgrass, WDFW mandates surveys prior to state harvest and a two-foot vertical buffer must be established around occurrences of rooted eelgrass. In areas with very shallow slopes, a 180-foot horizontal buffer (seaward and deeper than the deepest eelgrass) may be used instead of the vertical buffer (Bradbury et al. 2000).

## 4.5 Invasive and Exotic Flora and Fauna

*Spartina (Spartina sp.)*

*Spartina* is a highly aggressive and invasive aquatic plant species that can degrade the quality of tideflats. *Spartina* grows on tideflats and traps sediment from the water column, causing increased elevation and vegetation changes. These physical alterations can reduce productivity and habitat suitability for many native plant and animal species (Battelle et al. 2000).

*Spartina* was first discovered on Vashon Island in 1993 at Fern Cove on the northwest side of Vashon Island. Since then, *Spartina* has been found near the Maury Island site in Raab's Lagoon, Point Heyer, and Tramp Harbor. Populations found to date near the Maury Island site are small and have responded well to management (Eisenberg et al. 2001). In recent years, local organizations have surveyed the island by boat and reported findings to Washington Department of Agriculture for management.

While several other invasive species have been detected within or near the aquatic reserve, no systematic survey has attempted to assess which species are present. Table 3 describes non-native and cryptogenic species that have been detected in Puget Sound and several species on this list are likely to occur within the aquatic reserve. The information in this table on native regions, transport mechanisms and collections is based on Carlton 1979, Cohen & Carlton 1995, Cohen *et al.* 1998 and Mills *et al.* 2000 unless otherwise noted.

**Table 3 Exotic and Cryptogenic Species in Puget Sound**

| Organism | Records |
|---|---|
| **Phaeophyceae** | |
| *Sargassum muticum* (Yendo, 1907) Fensholt, 1955 | Native to Japan and introduced with oyster aquaculture. First recorded on Pacific Coast in 1944 and in Puget Sound in 1948; present throughout Puget Sound by the early 1960s (Scagel 1956; Thom & Hallum 1991). |
| **Anthophyta** | |
| *Cotula coronopifolia* Linnaeus, 1753 | Native to South Africa and probably introduced in solid ballast. First recorded on the Pacific Coast at San Francisco in 1878 and now spread from southern California to British Columbia, including Puget Sound. Often occurs as an ephemeral colonizer in newly restored salt marshes (Frenkel 1991). |
| *Spartina alterniflora* Loiseleur-Deslongchamps | Native to the northwestern Atlantic and first reported on the Pacific Coast in Puget Sound, where it was planted in the 1930s for duck habitat. It probably arrived earlier in Willapa Bay, where it may have been introduced in solid ballast, as seeds accidentally transported with oysters imported for culturing, or possibly as packing material for ship-transported goods. |
| *Spartina anglica* C.E. Hubbard, 1968 | A new species derived from accidental hybridization in southern England and northern France in the 1800s, Introduced to Puget Sound in Susan Bay for shoreline stabilization and cattle forage in 1961 (Frenkel 1987). |
| *Spartina patens* (Aiton) | Native to the northwestern Atlantic. Probably introduced as packing material for ship-transported goods, or possibly in solid ballast or as seeds accidentally transported with oysters imported for culturing. |
| *Zostera japonica* Ascherson and Graebner, 1907 | Native to the western Pacific and introduced with oyster aquaculture. First recorded on the Pacific Coast in 1957 and in Puget Sound in 1974 (Harrison & Bigley 1982). |
| **Foraminifera** | |
| *Trochammina hadai* Uchio 1962 | Native to Japan, and probably introduced either in ballast water, in hull fouling or with oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1971 (McGann *et al.* 2000). |
| **Cnidaria: Hydrozoa** | |
| *Cladonema radiatum* Dujardin, 1843 | Native to the Northwestern Atlantic. First collected on the Pacific Coast in Puget Sound in 1988 (Mills 1998). |
| *Cordylophora caspia* (Pallas, 1771) | Native to the Black and Caspian Seas. Either an early introduction with ballast water or possibly introduced in hull fouling. First recorded on the Pacific Coast in Puget Sound around 1920. Reported in some literature as *Cordylophora lacustris*. |
| **Cnidaria: Anthozoa** | |
| *Diadumene lineata* (Verrill, 1869) | Native to Asia. First recorded on the Pacific Coast in San Francisco Bay in 1906, and in Puget Sound in 1939. Either introduced in hull fouling from Asia, or with shipments of oysters from the Atlantic, where it had been introduced (probably in hull fouling) in the late 1880s. Reported in some earlier literature as *Haliplanella luciae*. |

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| **Platyhelminthes** | |
| *Pseudostylochus ostreophagus* Hyman, 1955 | An oyster pest native to Japan and introduced in oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1953. |
| **Annelida: Polychaeta** | |
| *Hobsonia florida* (Hartman, 1951) | Native to the northwestern Atlantic, and first recorded on the Pacific Coast in Puget Sound in 1940. |
| *Neanthes succinea* (Frey and Leuckart, 1847) | Native to the Atlantic and introduced by oyster aquaculture to San Francisco Bay by 1896. First recorded in Puget Sound around 1995. |
| *Pseudopolydora kempi* (Southern, 1921) | Native to Japan and probably introduced with oyster aquaculture, or possibly in hull fouling or ballast water. First recorded on the Pacific Coast at Nanaimo on the east coast of Vancouver Island in 1951, and in Puget Sound on San Juan Island in 1968. Has generally been listed as exotic on the Pacific Coast (Carlton 1979; Cohen & Carlton 1995; T N & Associates 2002); but was reported as cryptogenic in the Columbia River (Draheim et al. 2003). |
| *Pseudopolydora paucibranchiata* (Okuda, 1937) | Native to Japan and introduced with oysters, in hull fouling or in ballast water. First recorded on the Pacific Coast in southern California in 1950, and in Puget Sound in 1993. |
| **Mollusca: Gastropoda** | |
| *Batillaria attramentaria* (Sowerby, 1855) | A Japanese oyster pest introduced with oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1924, or possibly 19i8-19. Reported in some Pacific Coast literature as *B. zonalis* or *B. cumingi.* |
| *Crepidula fornicata* Linnaeus, 1758 | An oyster pest native to the northwestern Atlantic and introduced with oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1905. |
| *Crepidula plana* Say,1822 | Native to the northwestern Atlantic and introduced with oyster aquaculture. First recorded on the Pacific Coast in San Francisco Bay in 1901, and in Puget Sound in 1949. |
| *Myosotella myosotis* (Draparnaud, 1801) | Occurs on both coasts of the North Atlantic, but may be native only to Europe. First reported on the Pacific Coast in San Francisco Bay in 1871, where it was probably introduced with oyster aquaculture, although possibly carried in solid ballast or hull fouling. The first record in Puget Sound is from 1936, or possibly a 1927 specimen labeled "Juan de Fuca." It has since been reported from many locations in the Sound. |
| *Nassarius fraterculus* (Dunker, 1860) | Native to Japan and introduced with oyster aquaculture. First collected on the Pacific Coast in Puget Sound, in Padilla Bay in 1960 and Samish Bay in 1963 (Carlton 1979: 412). |
| *Ocinebrellus inornatus (Recluz, 1851)* | An oyster pest native to Japan and introduced with oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1924. Reported in some literature as *Ocenebra japonica* or *Ceratostoma inornatum*. |
| *Urosalpinx cinerea* (Say, 1822) | An oyster pest native to the northwestern Atlantic and introduced with oyster aquaculture. First recorded on the Pacific Coast in San Francisco Bay in 1890-91 and in Puget Sound in 1929. |

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| **Mollusca: Bivalvia** | |
| *Crassostrea gigas* (Thunberg, 1793) | Native to Japan and introduced for aquaculture. First planted on the Pacific Coast in Puget Sound in 1875. It is cultured extensively in South Puget Sound and reproduces successfully in Dabob Bay (Emmett *et al.* 1991). |
| *Musculista senhousia* (Benson, 1842) | Native to Asia and introduced with oyster aquaculture. First recorded on the Pacific Coast in Samish Bay on planted Japanese oysters, and found in the wild in central California in 1941 and in Puget Sound at Olympia in 1959. Reported in some literature as *Musculus senhousia*. |
| *Mya arenaria* Linnaeus, 1758 | Native to the northwestern Atlantic and introduced with oyster aquaculture. First recorded on the Pacific Coast in 1874, and in Puget Sound in 1888-89, where it is widely established (Emmett *et al.* 1991). |
| *Nuttallia obscurata* (Reeve, 1857) | Native to the northwestern Pacific and probably introduced in ballast water. First recorded on the Pacific Coast in 1991 and in Puget Sound in 1993 (Forsyth 1993). |
| *Venerupis philippinarum* (Adams & Reeve, 1850) | Native to the northwestern Pacific, accidentally introduced with oyster aquaculture. First recorded on the Pacific Coast in Puget Sound in 1924, where it is both widely cultivated and established in the wild (Emmett *et al.* 1991). Reported in some earlier literature as *Ruditapes philippinarum*, *Tapes japonica* or *Venerupis japonica.* |
| **Arthropoda: Crustacea: Copepoda** | |
| *Mytilicola orientalis* Mori, 1935 | Native to Asia and introduced in oyster aquaculture. First recorded on the Pacific Coast in Willapa Bay in 1938, and in Puget Sound in 1943. |
| **Arthropoda: Crustacea: Cumacea** | |
| *Nippoleucon hinumensis* (Gamo, 1967) | Native to Japan and introduced in ballast water. First recorded on the Pacific Coast in 1979, and in Puget Sound in the mid-1990s. Reported in some earlier literature as *Hemileucon hinumensis*. |
| **Arthropoda: Crustacea: Tanaidacea** | |
| *Sinelobus stanfordi* (Richardson, 1905) | Origin unknown. Possibly introduced in ship fouling or ballast water. First recorded on the Pacific Coast in 1943, and in Puget Sound since the mid-1990s. |
| **Arthropoda: Crustacea: Isopoda** | |
| *Caecidotea racovitzai* (Williams, 1970) | Native to the northwestern Atlantic and possibly introduced in ballast water or with aquarium or ornamental pond plants. Primarily occurs in fresh water, but has been collected in brackish water including the Snohomish River Estuary in 1997 (Toft *et al.* 2002). |
| *Limnoria tripunctata* Menzies, 1951 | Origin unknown. Introduced in hull fouling. First recorded on the Pacific Coast in California in the 1870s and in Puget Sound in 1962. |

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| **Arthropoda: Crustacea: Amphipoda** | |
| *Ampithoe valida* Smith, 1873 | Native to the northwestern Atlantic, and introduced by ballast water, oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1941, and in Puget Sound in 1966. |
| *Caprella mutica* Schurin, 1935 | Native to the Sea of Japan and introduced by ballast water or oyster aquaculture. First recorded on the Pacific Coast in 1973-77, and in Puget Sound in 1998. Reported in some literature as *Caprella acanthogaster*. |
| *Eochelidium* sp. | Probably native to Japan or Korea, and introduced in ballast water. First recorded on the Pacific Coast around 1993, and in Puget Sound in 1997. |
| *Grandidierella japonica* Stephensen, 1938 | Native to Japan, and introduced by ballast water, oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1966, and in Puget Sound in 1977. |
| *Jassa marmorata* Holmes, 1903 | Native to the northwestern Atlantic and introduced in ballast water or hull fouling. First recorded on the Pacific Coast in 1938, and in Puget Sound around 1995. |
| *Melita nitida* Smith, 1873 | Native to the northwestern Atlantic, and introduced by ballast water, oyster aquaculture, solid ballast or hull fouling. First recorded on the Pacific Coast in 1938. |
| *Monocorophium acherusicum* Costa, 1857 | Native to the northern Atlantic, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1905, and in Puget Sound in 1974-75. Reported in the literature as *Corophium acherusicum* until recently. |
| *Monocorophium insidiosum* Crawford, 1937 | Native to the northern Atlantic, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1915 and in Puget Sound in 1949. Reported in the literature as *Corophium insidiosum* until recently. |
| *Parapleustes derzhavini* (Gurjanova, 1938) | Native to the western Pacific and introduced in hull fouling. First recorded on the Pacific Coast in 1904, and in Puget Sound in 1998. |
| **Kamptozoa** | |
| *Barentsia benedeni* (Foettinger, 1887) | Native to Europe, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1929, and in Puget Sound in 1998. |
| **Bryozoa** | |
| *Bowerbankia gracilis* Leidy, 1855 | Probably native to the western Atlantic, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast by 1923, and in Puget Sound by 1953. |
| *Bugula* sp. A | First recorded on the Pacific Coast in Puget Sound in 1993. |
| *Bugula* sp. B | First recorded on the Pacific Coast in Puget Sound in 1998. |
| *Bugula stolonifera* Ryland, 1960 | Native to the northwestern Atlantic and introduced in hull fouling. First recorded on the Pacific Coast by 1978, and in Puget Sound in 1998. |
| *Cryptosula pallasiana* (Moll, 1803) | Native to the northern Atlantic, and introduced with oyster aquaculture or in hull fouling. First recorded on the Pacific Coast in 1943-44 and, in Puget Sound in 1998. |
| *Schizoporella unicornis* (Johnston, 1847) | Native to the northwestern Pacific, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in Puget Sound in 1927. |

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| **Urochordata: Tunicata** | |
| *Botrylloides violaceus* Oka, 1927 | Native to Japan, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1973, and in Puget Sound in 1977. |
| *Botryllus schlosseri* (Pallas, 1766) | Native to the northeastern Atlantic, and introduced by oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1944-47, and in Puget Sound in the 1970s. |
| *Ciona savignyi* Herdman, 1882 | Native to Japan, and introduced in ballast water or hull fouling. First recorded on the Pacific Coast in 1985, and in Puget Sound in 1998. |
| *Molgula manhattensis* (DeKay, 1843) | Native to the northwestern Atlantic, and introduced by ballast water, oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1949, and in Puget Sound in 1998. |
| *Styela clava* Herdman, 1881 | Native to the region from China to the Sea of Okhotsk, and introduced by ballast water, oyster aquaculture or hull fouling. First recorded on the Pacific Coast in 1932-33, and in Puget Sound in 1998. |
| **Chordata: Pisces** | |
| *Alosa sapidissima* (Wilson, 1811) | Native to the northwestern Atlantic, and intentionally introduced to the San Francisco Bay watershed in 1871. Collected in the Columbia River in 1876 (Smith 1896), and fry were stocked there in 1906 (Draheim 2002: 11). Adults and juveniles are common in Skagit Bay, and rare in other parts of Puget Sound (Emmett *et al.* 1991). |

## 5.0 Species Observation Lists for Maury Island Aquatic Reserve

Tables 4 – 9 describe all species observations within or adjacent to the proposed Maury Island Aquatic Reserve. These observations are largely derived from Blau's (1975) efforts. Special status refers to listing by the State of Washington or the Federal Government as threatened, endangered, species of concern or monitor species.

**Table 4: Mammals Observed near Aquatic Reserve**

| Common Name | Scientific name | Special status |
|---|---|---|
| **Little Brown Myotis** | ***Myotis lucifugus alascensis*** | |
| **Yuma Myotis** | ***Myotis yumanensis saturatus*** | |
| **California Myotis** | ***Myotis californicus caurinus*** | |
| **Silver-Haired Bat** | ***Lasionycteris noctivagans*** | |
| **Big Brown Bat** | ***Eptesicus fuscus bernardinus*** | |
| **Hoary Bay** | ***Lasiurus cinereus cinereus*** | |
| **Black Rat** | ***Rattus rattus*** | |
| **Norway Rat** | ***Rattus norvegicus*** | |
| **Raccoon** | ***Procyon lotor pacificus*** | |
| **River Otter** | ***Lutra canadensis pacifica*** | |
| **Harbor Porpoise** | ***Phocoena phocoena*** | **State Concern** |
| **Killer Whale** | ***Orcinus orca*** | **Federal Concern, State Endangered** |
| **Harbor Seal** | ***Poca vitulina richardi*** | |
| **Minke Whale** | ***Balaenoptera acutorostrata*** | |

**Table 5: Birds observed near Aquatic Reserve**

| Common Name | Scientific name | Special status |
|---|---|---|
| **Common Loon** | ***Gavia immer*** | **State Sensitive** |
| **Red-throated loon** | ***Gavia stellata*** | |
| **Arctic loon** | ***Gavia arctica pacifica*** | |
| **Red-necked Grebe** | ***Podiceps grisegena holbollii*** | |
| **Horned Grebe** | ***Podiceps auritus cornutus*** | |
| **Eared Grebe** | ***Podiceps caspicus californicus*** | |
| **Western Grebe** | ***Anchamphorus occidentalis*** | **State Concern** |
| **Pied-billed Grebe** | ***Podilymbus podiceps podiceps*** | |
| **Leach's Petrel** | ***Oceanodroma leucorhoa beali*** | |
| **Brandt's Cormorant** | ***Phalacrocorax penicillatus*** | **State Concern** |
| **Pelagic Cormorant** | ***Phalacrocorax pelagicus resplendens*** | |
| **Double-crested Cormorant** | ***Phalacrocorax auritus albociliatus*** | |
| **Great Blue Heron** | ***Ardea herodias fannini*** | **State Monitor** |
| **Whistling Swan** | ***Olor columbianus*** | |
| **Aleutian Goose** | ***Branta canadensis leucopareia*** | **Federal Concern, State Threatened** |
| **Canada Goose** | ***Branta candensis minima*** | |
| **Brant** | ***Branta nigricans*** | |
| **White-fronted Goose** | ***Anser albifrons frontalis*** | |
| **Snow Goose** | ***Chen hyperborea*** | |
| **Mallard** | ***Anas platyrhynchos platy rhychos*** | |
| **Gadwall** | ***Anas strepera*** | |
| **Pintail** | ***Anas acuta*** | |
| **Green-winged Teal** | ***Anas crecca carolinensis*** | |
| **Blue-winged Teal** | ***Anas discors discors*** | |
| **American Widgeon** | ***Anas americana*** | |
| **Shoveler** | ***Anas clypeata*** | |
| **Canvasback** | ***Aythya valisineria*** | |
| **Greater Scaup** | ***Aythya marila nearctica*** | |
| **Common Goldeneye** | ***Becephala clangula americana*** | |
| **Barrow's Goldeneye** | ***Bucephala islandica*** | |
| **Bufflehead** | ***Bucephala albeola*** | |
| **Oldsquaw** | ***Clangula hyuemalis*** | |
| **Harlequin Duck** | ***Histrionicus histrionicus*** | |
| **White-winged Scoter** | ***Melanitta deglandi dixoni*** | |
| **Surf Scoter** | ***Melanitta perspicillata*** | |
| **Common Scoter** | ***Oldemia nigra americana*** | |
| **Hooded Merganser** | ***Lophodytes cucullatus*** | |
| **Common Merganser** | ***Mergus merganser americansus*** | |
| **Red-Breasted Merganser** | ***Mergus serrator serrator*** | |
| **Bald Eagle** | ***Haliaetus leucocephalus alascanaus*** | **Federal Threatened, State Threatened** |
| **Osprey** | ***Pandion haliaetus carolinensis*** | |
| **Peregrine Falcon** | ***Falco peregrinus pealei*** | **Federal Concern, State Threatened** |
| **American Coot** | ***Fulica americana americana*** | |
| **Semipalmated Plover** | ***Charadrius semipalmatus*** | |

| | | |
|---|---|---|
| **Killdeer** | ***Charadrius vociferus*** | |
| **Black-bellied Plover** | ***Pluvialis squatarola*** | |
| **Common snipe** | ***Capella gallinago delicata*** | |
| **Greater Yellowlegs** | ***Tringa melanoleucus*** | |
| **Pectoral Sandpiper** | ***Calidris melanotos*** | |
| **Knot** | ***Calidris canutus canutus*** | |
| **Least Sandpiper** | ***Calidris minutilla*** | |
| **Dunlin** | ***Calidris alpina pacifica*** | |
| **Short-billed Dowitcher** | ***Limnodromus griseus caurinus*** | |
| **Western Sandpiper** | ***Ereunetes mauri*** | |
| **Marbled Godwit** | ***Limosa fedoa*** | |
| **Sanderling** | ***Crocethia alba*** | |
| **Northern Phalarope** | ***Lobopes lobatus*** | |
| **Parasitic Jaeger** | ***Stercorarius parasiticus*** | |
| **Glaucous-winged Gull** | ***Larus hyperboreus barrevianus*** | |
| **Herring Gull** | ***Larus argentatus smithsonianus*** | |
| **Thayer's Gull** | ***Larus thayeri*** | |
| **California Gull** | ***Larus californicus*** | |
| **Ring-billed Gull** | ***Larus delawarensis*** | |
| **Mew Gull** | ***Larus canus brachyrhynchus*** | |
| **Western Gull** | ***Larus occidentalia*** | |
| **Bonapartes Gull** | ***Larus philadephia*** | |
| **Heermann's Gull** | ***Larus heermanni*** | |
| **Forster's Tern** | ***Sterna forsteri*** | |
| **Pigeon Guillemot** | ***Cepplus columba columba*** | |
| **Marbled Murrelet** | ***Brachyramphus marmoratum marmoratum*** | **Federal Threatened, State Threatened** |
| **Ancient Murrelet** | ***Synthliboramphus antiquum*** | |
| **Rhinoceros Auklet** | ***Cerorhinca monocerata*** | |
| **Snowy Owl** | ***Nyctea scandiaca*** | |
| **Belted Kingfisher** | ***Megaceryle alcyon caurina*** | |
| **Traill's Flycatcher** | ***Empidonax traillii brewsteri*** | |
| **Common Crow** | ***Corvus brachyrhynchos herperis*** | |
| **Northwestern Crow** | ***Corvus brachyrhynchos caurinus*** | |
| **Water Pipit** | ***Anthus spinoletta pacificus*** | |

Table 6: Fish observed near Aquatic Reserve

| Common Name | Scientific name | Special status |
|---|---|---|
| **Pacific lamprey** | ***Entosphenus tridentatus*** | |
| **Brown cat shark** | ***Apristurus brunneus*** | |
| **Spiny dogfish** | ***Squalus acanthias*** | |
| **Big skate** | ***Raja binoculata*** | |
| **longnose skate** | ***Rraja rhina*** | |
| **Ratfish** | ***Hydrolagus colliei*** | |
| **Pacific herring** | ***Clupea harengus pallasi*** | |
| **Pink salmon** | **Oncorhychus gorbuscha** | |
| **Chum salmon** | **Oncorhychus keta** | |
| **Coho salmon** | **Oncorhychus kisutch** | Federal Concern |
| **Sockeye salmon** | **Oncorhychus nerka** | |
| **Chinook salmon** | **Oncorhychus tshawytscha** | Federal Threatened, State Concern |
| **Cutthroat trout** | **Slmo clarki** | |
| **Steelhead trout, rainbow trout** | **Salmo gairdneri** | |
| **Surf smelt** | **Hypomesus pretiosus** | |
| **Longnose lancefish** | **Alepisaurus ferox** | |
| **Plainfin midshipman** | **Porichthys notatus** | |
| **Pacific cod** | **Gadus macrocephalus** | State Concern |
| **Pacific hake** | **Merluccius productus** | Federal Concern, State Concern |
| **Pacific tomcod** | **Microgadus proximus** | |
| **Walleye pollock** | **Thragra chalcogramma** | State Concern |
| **Tube-snout** | **Aulorhynchus flavidus** | |
| **Threespine stickleback** | **Gasterosteus aculeatus** | |
| **Bay pipefish** | **Syngnathus griseolineatus** | |
| **Shiner perch** | **Cymatogaster aggregata** | |
| **Striped seaperch** | **Embiotoca lateralis** | |
| **Pile perch** | **Rhacochilus vacca** | |
| **Northern ronquil** | **Ronquilus jordani** | |
| **High cockscomb** | **Anoplarchus purpurescens** | |
| **Snake prickleback** | **Lumpenus sagitta** | |
| **Saddleback gunnel** | **Pholis ornata** | |
| **Arrow goby** | **Clelandia ios** | |
| **Ragfish** | **Icosteus aenigmaticus** | |
| **Brown rockfish** | **Sebastes auriculatus** | State Concern |
| **Copper rockfish** | **Sebastes caurinus** | State Concern |
| **Yellowtail rockfish** | **Sebastes flavidus** | State Concern |
| **Quillback rockfish** | **Sebastes maliger** | State Concern |
| **Black rockfish** | **Sebastes melanops** | State Concern |
| **Blue rockfish** | **Sebastes mystinus** | |
| **Canary rockfish** | **Sebastes pinniger** | State Concern |
| **Shortbelly rockfish** | **Sebastes jordani** | |
| **Bocacciao** | **Sebastes paucispinus** | State Concern |
| **Sablefish** | **Anoplopoma fimbria** | |
| **Kelp greenling** | **Hexagrammos decagrammus** | |
| **Whitespotted greenling** | **Hexagrammos stelleri** | |
| **Lingcod** | **Ophiodon elongatus** | |
| **Silverspot sculpin** | **Blpsias cirrhosus** | |

| | | |
|---|---|---|
| **roughback sculpin** | **Chitonotus pugetensis** | |
| **Buffalo sculpin** | **Enophrys bison** | |
| **Red Irish lord** | **Hemilepidotus hemilepidotus** | |
| **Pacific staghorn sculpin** | **Leptocottus armatus** | |
| **Slim sculpin** | **Radulinus asprellus** | |
| **Cabezon** | **Scorpaenichthys marmoratus** | |
| **Blacktip poacher** | **Xeneretmus latifrons** | |
| **Pacific sanddab** | **Citharichthys sordidus** | |
| **Arrowtooth flounder** | **Atheresthes stomias** | |
| **Petrale sole** | **Eopsetta jordani** | |
| **Rex sole** | **Glyptocephalus zachirus** | |
| **Flathead sole** | **Hippoglossoides elassodon** | |
| **Rock sole** | **Lepidopsetta bilineata** | |
| **Butter sole** | **Isopsetta isolepis** | |
| **Slender sole** | **Lyopsetta exilis** | |
| **Dover sole** | **Microstomus pacificus** | |
| **English sole** | **Parophrys vetulus** | |
| **Starry flounder** | **Platichthys stellatus** | |
| **C-O sole** | **Pleuronichthys coenosus** | |
| **Sand sole** | **Psettichthys melanostictus** | |

Table 7: Marine Invertebrates observed near Aquatic Reserve

| Common Name | Scientific name | status |
|---|---|---|
| **Sponge** | **Haliclona permollis** | |
| **Crumb-of-bread sponge** | **Halichondria panicea** | |
| **Hydroid** | **Obelia longissima** | |
| **Hydroid** | **Obelia spp.** | |
| **Hydromedusae** | **Aequorea aequorea** | |
| **Other hydromedusae spp.** | | |
| **Scphozoans** | **Cyanea capillata** | |
| **Stalked anemone** | **Metridium senile** | |
| **Anemone** | **Pachyceriantus fimbriatus** | |
| **Sea pen** | **Ptilosarcus gurneyi** | |
| **Sea pen** | **Stylatula elongata** | |
| **Flatworms** | **Phylum Platyhelminthes** | |
| **Mussel Nemertean** | **Emplectonema gracile** | |
| **Ribbon worm** | **Paranemertes pergrina** | |
| **Other nemerteans** | | |
| **Chiton spp.** | **Mopalia Ignosa** | |
| **Chiton spp.** | **Mopalia sp.** | |
| **Lined chiton** | **Tonicella lineata** | |
| **Shield limpet** | **Collisella pelta** | |
| **Limpet** | **Collisella spp.** | |
| **Half-slipper shell** | **Crepipatella lingulata** | |
| **Chink shell** | **Lacuna variegata** | |
| **Checkered periwinkle** | **Littorina scutulata** | |
| **Sitka periwinkle** | **Littorina sitkana** | |
| **Lean-basket snail** | **Nassarius mendicus** | |
| **Mask limpet** | **Notoacmea persona** | |
| **Moon snail** | **Polinices lewisii** | |
| **Dogwinkle** | **Thais emarginata** | |
| **Toothed snail** | **Thais lamellosa** | |
| **Sea slugs** | **Armina californica** | |
| **Sea slugs** | **Dirona albolineta** | |
| **Sea slugs** | **Eubranchus olivaceus** | |
| **Sea slugs** | **Hermissenda crassicornis** | |
| **Octopus** | **Octopus dolfleini** | |
| **Octopus** | **Octopus spp.** | |
| **Scallop** | **Chlamys spp.** | |
| **Heart cockle** | **Clinocardium nuttalli** | |
| **Pacific oyster** | **Crassostrea gigas** | |
| **Ringed lucine** | **Lucinoma annulata** | |
| **Inconspicuous macoma** | **Macoma balthica** | |
| **Polluted macoma** | **Macoma inquinata** | |
| **Bent-nosed clam** | **Macoma nasuta** | |
| **Sand clam** | **Macoma secta** | |
| **Soft-shell clam** | **Mya arenaria** | |
| **Truncate soft shell** | **Mya truncata** | |
| **Horse mussel** | **Modiolus rectus** | |
| **Blue mussel** | **Mytilus edulis** | |

| | | |
|---|---|---|
| Geoduck | Panope generosa | |
| Native littleneck clam | Protothaca staminea | |
| Butter clam | Saxidomus giganteus | |
| Jacknife clam | Solen sicarius | |
| Horse clam, Alaska gaper | Tresus capax | |
| Horse clam, Pacific gaper | Tresus nuttalli | |
| Manila clam | Venerupis japonica | |
| Thin-shelled littleneck | Venerupis tenerrima | |
| Pilsbry piddock | Zirfaea pilsbryi | |
| Little transennela | Transennela tantilla | |
| Pacific lugworm | Abarenicola pacifica | |
| Polychete | Arctoneoe fragilis | |
| Bamboo worm | Axiothella rubrocincta | |
| Capitellid | Cheilonereis cyclurus | |
| Feather duster worm | Eudistyliua vancoveri | |
| Capitellid | Glycera spp. | |
| Scale worm | Halosydna brevisetosa | |
| Capitellid | Hemipodus borealis | |
| Capitellid | Nephtys sp. | |
| Capitellid | Nereis brandti | |
| Pile worm | Nereis vexillosa | |
| Ophelidid | Phyllochaetopterus prolifera | |
| Limy-tubed worm | Serpula vermicularis | |
| Ophelidid | Spirorbis sp. | |
| Barnacle | Cthamalus dalli | |
| Rock barnacle | Balanus cariosus | |
| Barnacle | Balanus crenatus | |
| Acorn barnacle | Balanus glandula | |
| Isopod | Cirolana kincaidi | |
| Isopod | Idotea wosnesenskii | |
| Amphipod | Caprella equilibra | |
| Amphipod | Metacaprella kennerlyi | |
| Beach hopper, sand flea | Orchestia traskiana | |
| Ghost shrimp | Callianassa californiensis | |
| Graceful crab | Cancer gracilis | |
| Red crab | Cancer productus | |
| Shrimp | Crangon sp. | |
| Purple shore crab | Hemigrapsus nudus | |
| Green shore crab | Hemigrapsus oregonensis | |
| Black-clawed crab | Lophopanopeus bellus | |
| Hermit crab | Pagurus armatus | |
| Hermit crabs | Pagurus spp. | |
| Shrimp | Pandalus spp. | |
| Pea crab | Pinnixa faba/ Pinnixa littoralis | |
| Spider crab | Pugettia gracilis | |
| Kelp crab | Pugettia producta | |
| Bryzoan | Dendrobeania lichenoides | |
| Bryzoan | Membranipora | |
| Rose star | Crossaster papposus | |

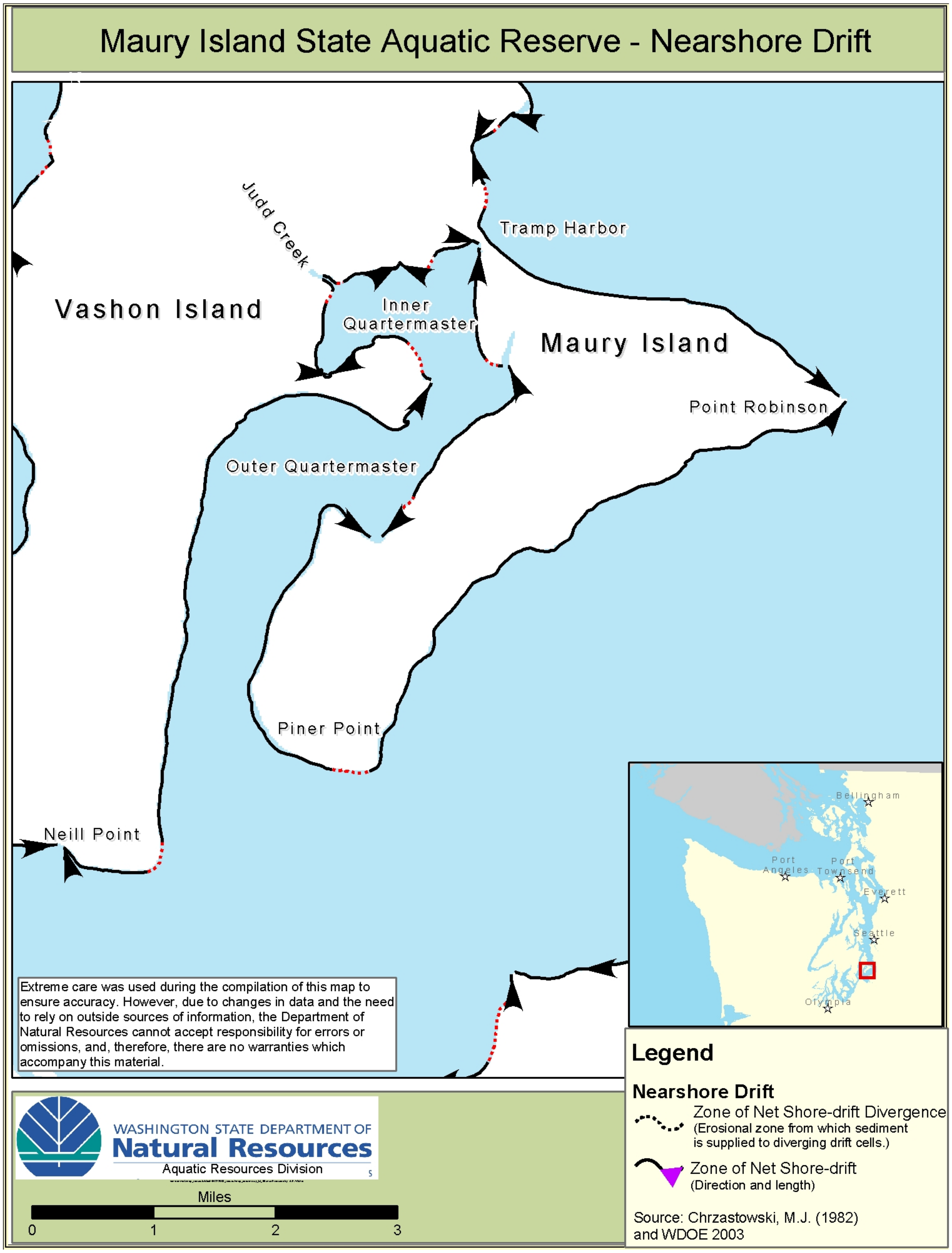
| | | |
|---|---|---|
| **Leather star** | **Dermasterias imbricata** | |
| **Mottled star** | **Evasterias troschelii** | |
| **Blood star** | **Henricia leviuscula** | |
| **Vermillion star** | **Mediaster aequalis** | |
| **Pink starfish** | **Pisaster brevispinus** | |
| **Sunflower star** | **Pycnopodia helianthoides** | |
| **Sun star** | **Solaster stimpsoni** | |
| **Sand dollar** | **Dendraster excentricus** | |
| **Green sea urchin** | **Strongylocentrotus droebachiensis** | |
| **Sea cucumber** | **Cucumaria miniata** | |
| **Sea cucumber** | **Eupentacta quinquesemita** | |
| **California sea cucumber** | **Parastichopus californicus** | |
| **Ascidians** | **Ascidia callosa** | |
| **Ascidians** | **Ascidia paratropa** | |
| **Sea squirts** | **Chelyosoma productum** | |
| **Sea squirts** | **Distaplia occidentalis** | |
| **Sea squirts** | **Styela gibbsii** | |
| **Sea squirts** | **Tunicate spp.** | |

Table 9: Aquatic Vegetation observed Near Aquatic Reserve

| Common Name | Scientific name | status |
|---|---|---|
| **Pickleweed** | **Salicornia virginica** | |
| **Eelgrass** | **Zostera marina** | |
| **Eelgrass** | **Zostera japonica** | |
| **Sea fern** | **Bryopsis corticularis** | |
| **Link confetti** | **Enteromorpha intestinalis** | |
| **Sea lettuce** | **Ulva lactuca** | |
| **Schizonema** | **Navicula spp.** | |
| **Diatom** | **Pleurosigma fasciola** | |
| **Red algae** | **Agardhiella tenera** | |
| **Red algae** | **Callophyllis sp.** | |
| **Red algae** | **Ceramium sp.** | |
| **Turkish towel** | **Gigartina exasperata** | |
| **Red algae** | **Gracilariopsis sjoestedtii** | |
| **Pink rock crust** | **Lithothamnion sp.** | |
| **Red algae** | **Neodilsea amercana** | |
| **Red algae** | **Polysiphonia sp.** | |
| **Red algae** | **Pterosiphonia sp.** | |
| **Red algae** | **Rhodoptilum plumosum** | |
| **Brown algae** | **Colpomenia sinuosa** | |
| **Brown algae** | **Cystoseira germinata** | |
| **Rockweed** | **Fucus gardneri** | |
| **Hairy rockweed** | **Fucus spiralis** | |
| **Sugar wrack** | **Laminaria sacchirina** | |
| **Bull kelp** | **Nerocystis luetkeana** | |
| **Brown algae** | **Petalonia debilis** | |
| **Japanese weed** | **Sargassum muticum** | |
| **Whip tube** | **Scytosiphon lomentaria** | |

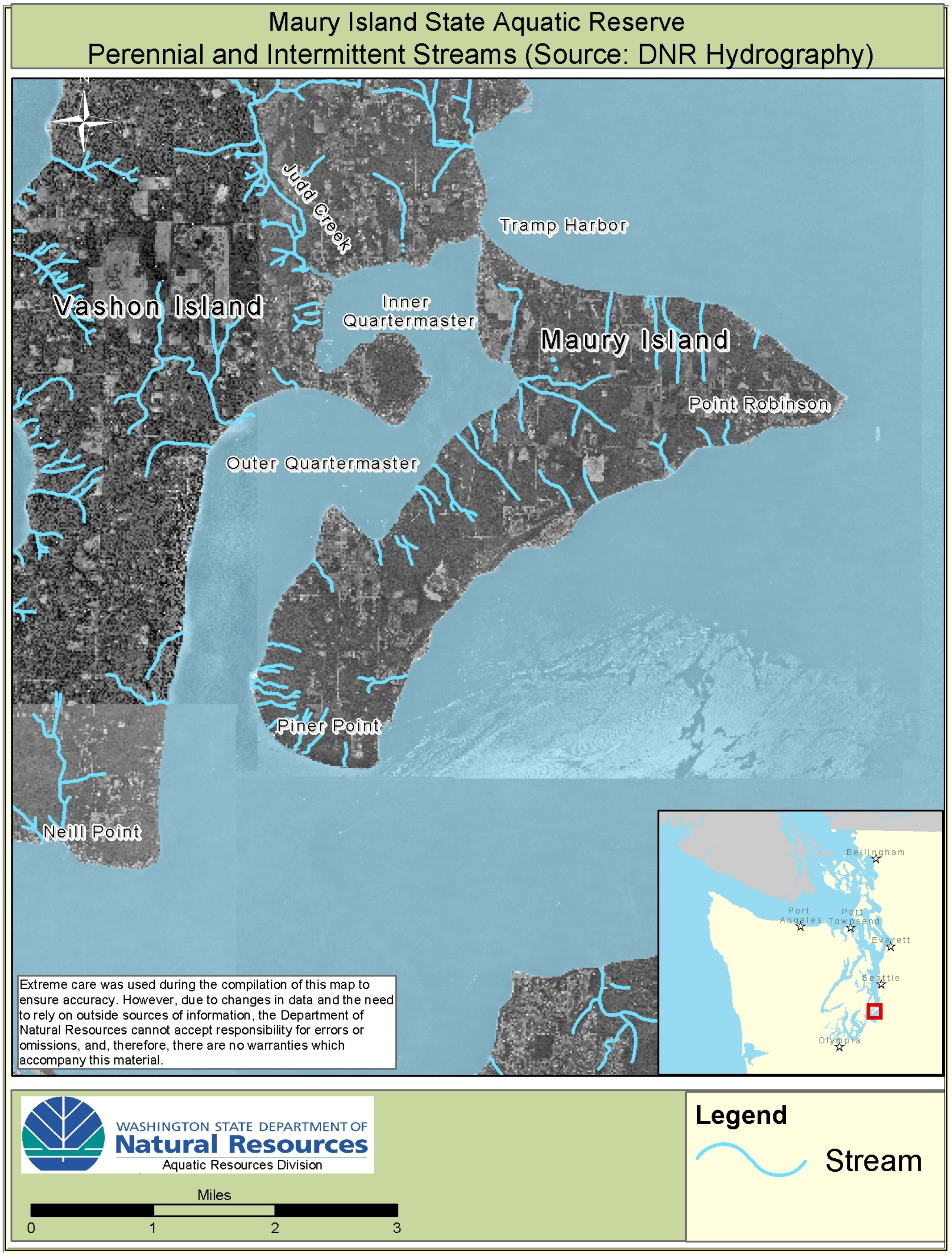
# Appendix D– Drift Cells

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm



# Appendix E – Tributary Streams

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

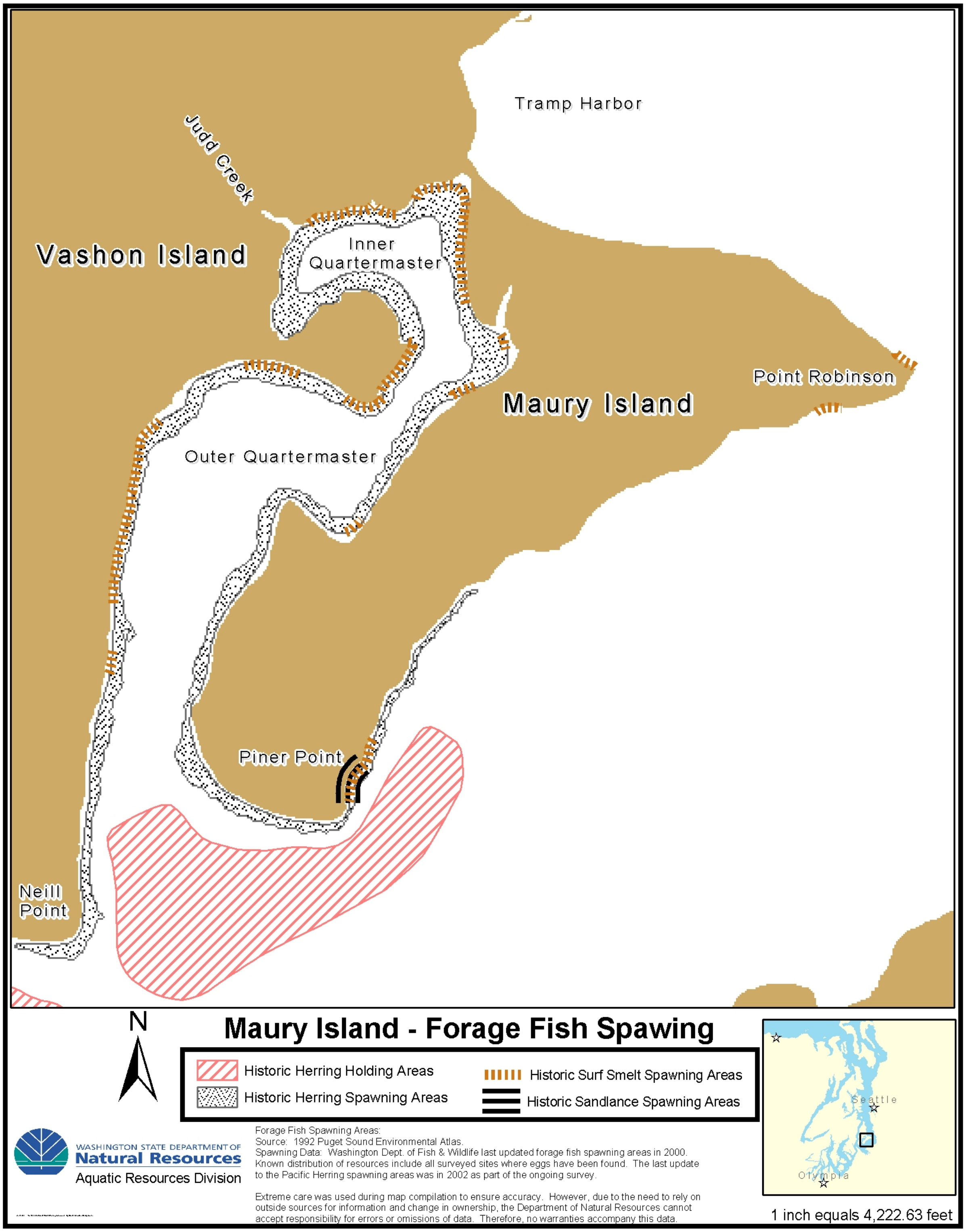


# Appendix F – Aquatic Vegetation

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

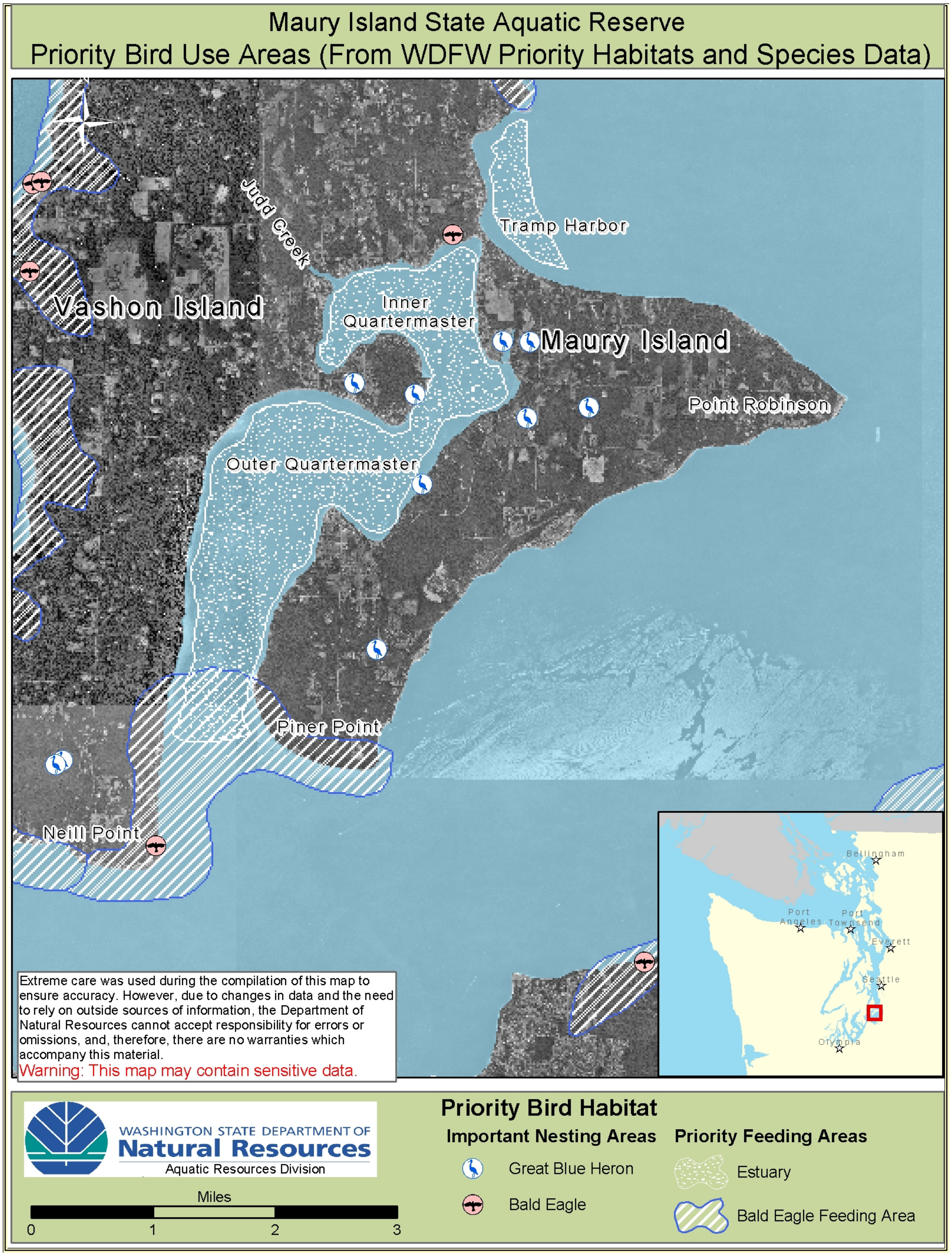
# Appendix G – Forage Fish Spawning

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm



# Appendix H – Priority Bird Use Areas

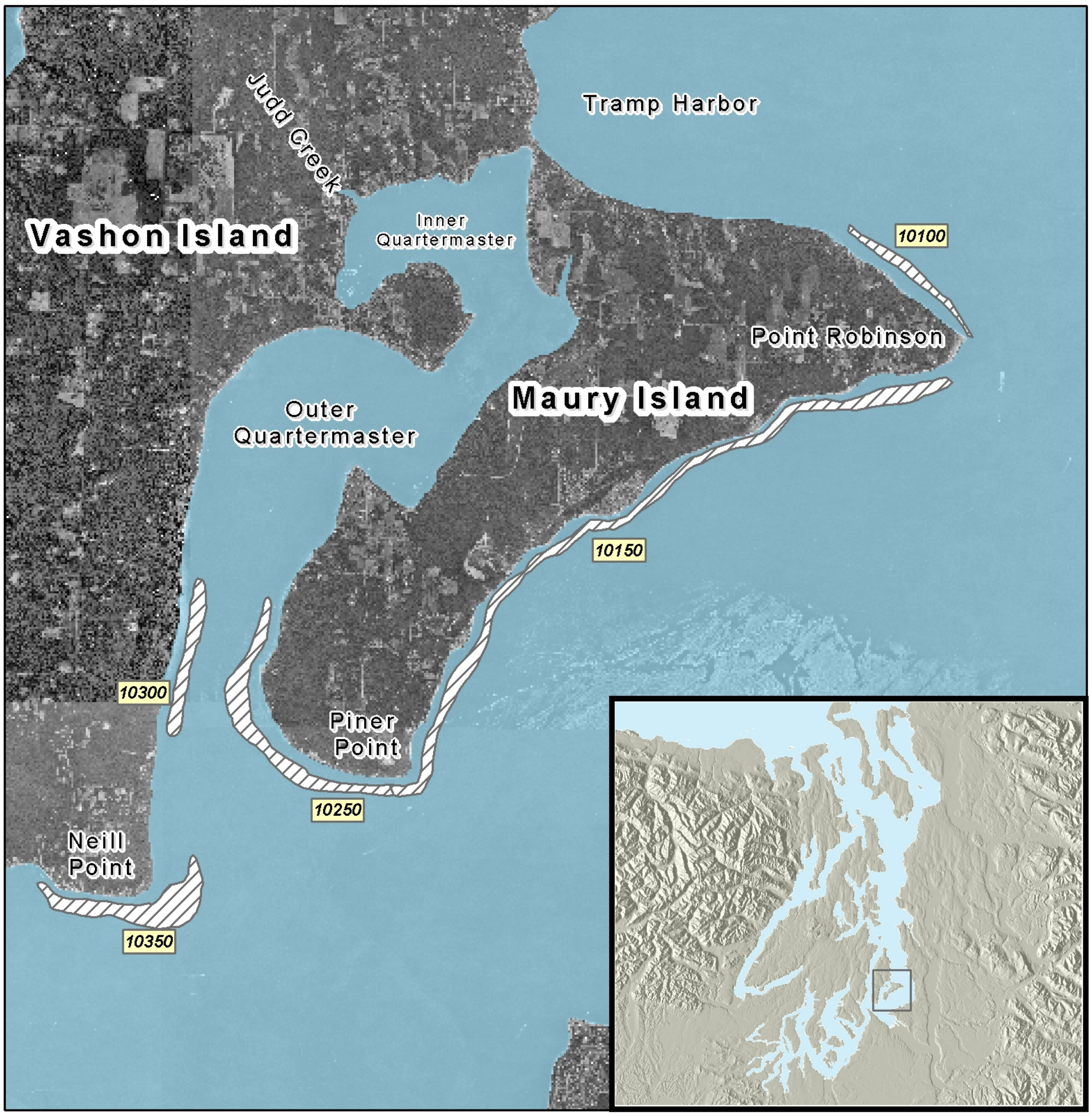
For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm



# Appendix I – Geoduck Tracts

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

## Commercial Geoduck Tracts Within The Maury Island Aquatic Reserve




Extreme care was used during the compilation of this map to ensure accuracy. However, due to changes in data and the need to rely on outside sources of information, the Department of Natural Resources cannot accept responsibility for errors or omissions, and, therefore, there are no warranties which accompany this material.

0 0.4 0.8 1.6 2.4 3.2 Miles

**Legend**

Geoduck Tracts

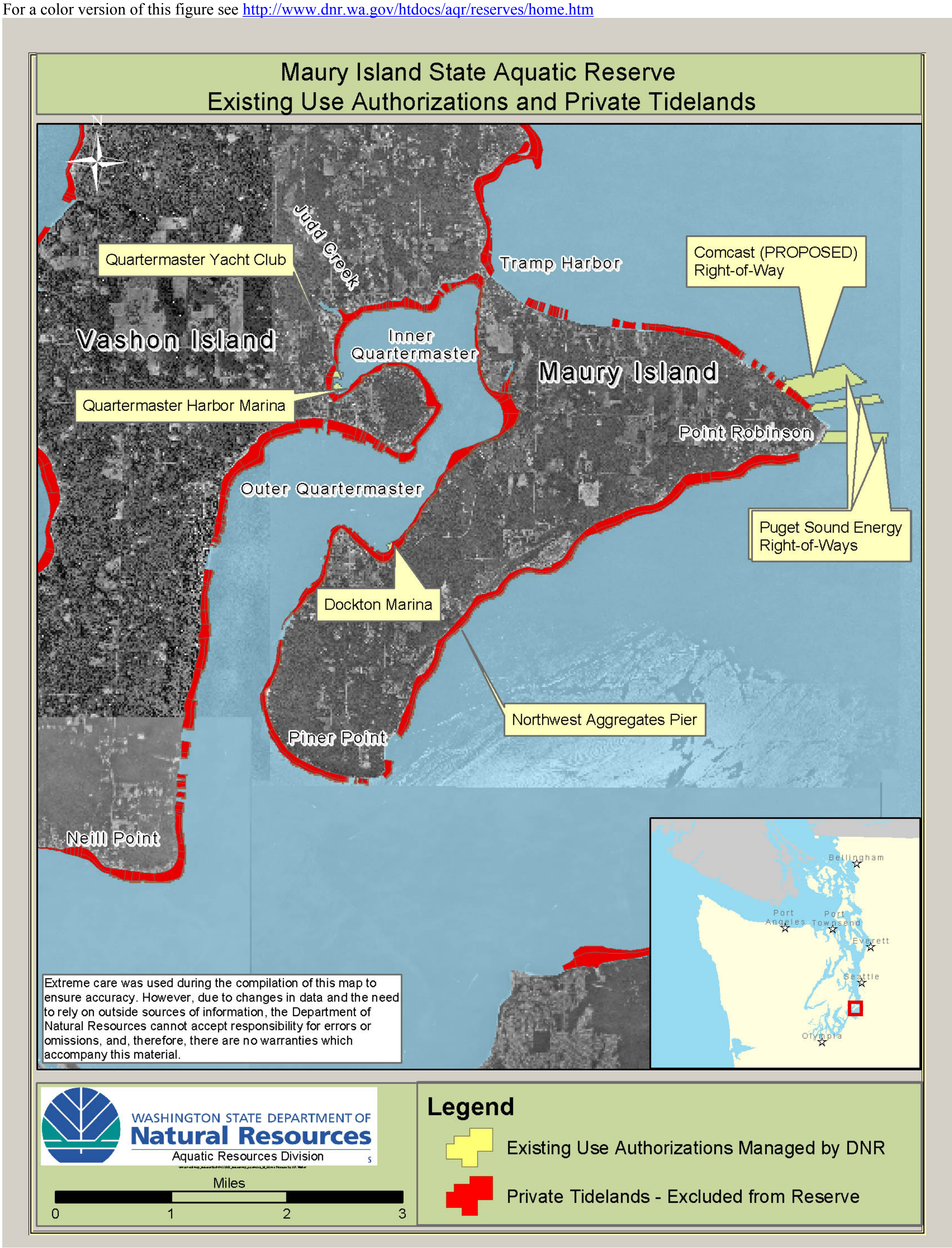
10300 Geoduck Tract Number

09/09/2003 - Aquatic Resources

WASHINGTON STATE DEPARTMENT OF
Natural Resources
Doug Sutherland - Commissioner of Public Lands

# Appendix J – Existing Use Authorizations

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

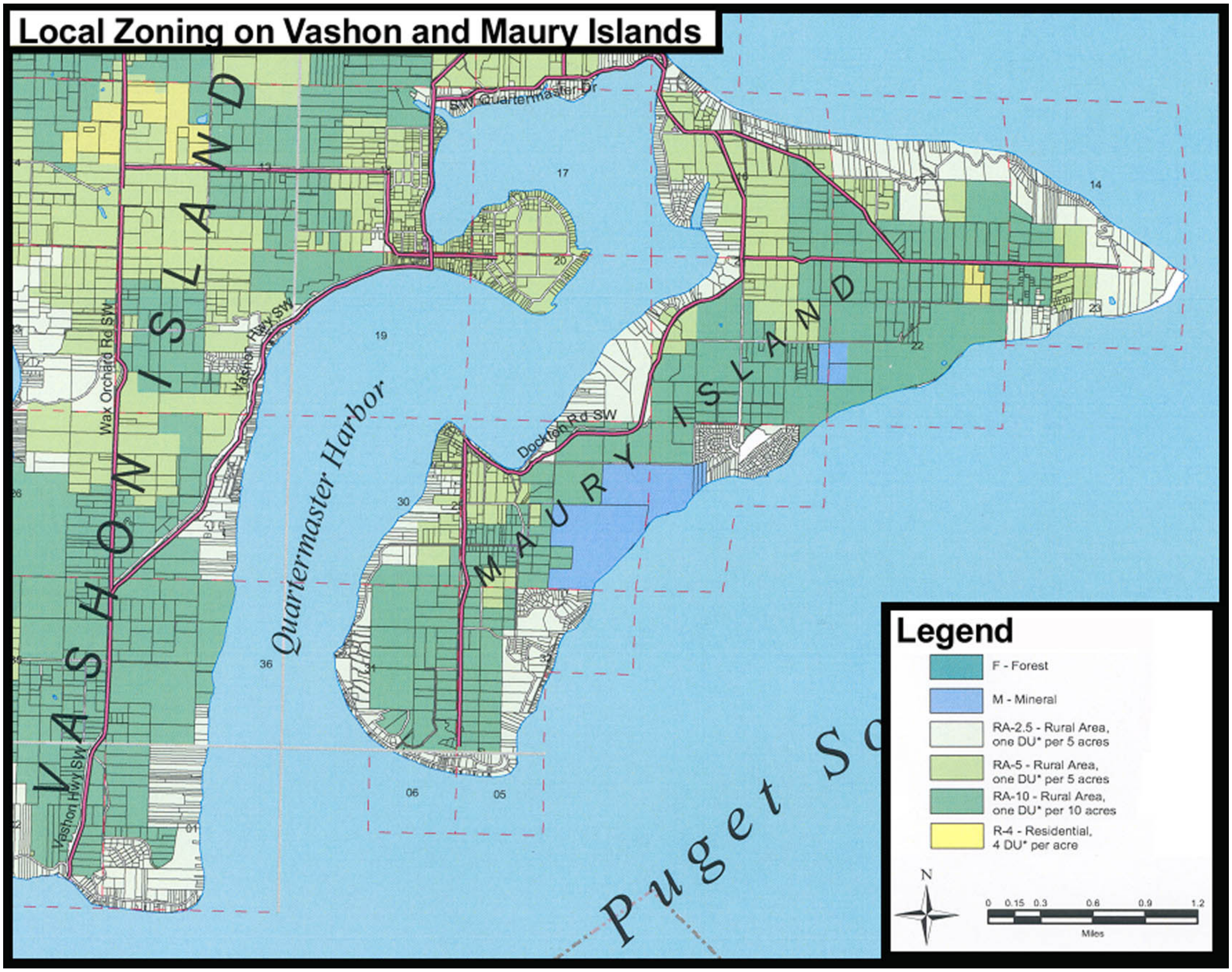


# Appendix K – Shoreline Zoning

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

# Appendix L – Land Use Designations

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm



# Appendix M: Shoreline Modifications

For a color version of this figure see http://www.dnr.wa.gov/htdocs/aqr/reserves/home.htm

# Appendix N– Programmatic Management Matrix

| LOCATION | MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | GOAL |
|---|---|---|---|
| Reserve-Wide | Cooperative Management | Identify local, state, federal, and tribal stakeholders<br>Collaborate on a project-specific basis with stakeholders | Improve interagency communication<br>Coordinate aquatic resource and shoreline management strategies |
| | Management Plan Updates | Review & update every 10 years based on budget and staffing<br>Establish long-term quantifiable resource goals<br>Implement adaptive management | Ensure management plan success |
| | Research | Identify historical research conducted for site<br>Identify ongoing research conducted at site<br>Compile database of historical research<br>Identify outstanding research needs for the site<br>Identify research partners<br>Develop long-term research plan<br>Establish reserve-wide baseline conditions<br>Establish resource specific goals | Establish Baseline Conditions<br>Improve understanding of reserve resources<br>Establish long-term resource goals |
| | Monitoring | Establish long-term monitoring plan<br>Identify monitoring partners<br>Implement assessments of dissolved oxygen, nitrates, fecal coliform, suspended solids, and water column transparency<br>Conduct surveys of eelgrass, kelp, forage fish spawning, shoreline development, and beach substrate | Ensure management plan success<br>Establish Long-term resource goals<br>Better understand resources within the reserve |
| Use Authorizations On State-owned Aquatic Lands | Existing Uses of State-owned Aquatic Lands | Existing terms & conditions honored<br>May conduct maintenance and construction<br>Identify baseline conditions of habitats & species<br>Work to decrease existing impacts<br>May be re-assigned<br>May be processed for re-authorization | Maintain site-specific baseline conditions<br>Improve site-specific baseline conditions where necessary |

| LOCATION | MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | GOAL |
|---|---|---|---|
| | Re-authorization of Existing Uses and Authorization of New Uses | Must primarily serve objective of reserve<br>Identify baseline conditions of habitats & species<br>Create no additional impacts<br>Show success on compensatory mitigation<br>Reduce impacts over time (plan)<br>Monitor impacts (plan)<br>Implement adaptive management (plan) | Maintain site-specific baseline conditions<br><br>Improve site-specific baseline conditions where necessary |
| DNR Led Activities Within Reserve | Derelict Vessels | Inventory existing derelict or abandoned vessels<br>Identify new derelict or abandoned vessels<br>Remove as per derelict vessel program guidelines | Maintain or improve reserve-wide baseline conditions |
| | Land Acquisition for Habitat | Establish priorities<br>Identify acquisition opportunities<br>Seek funding for purchase | Maintain or improve reserve-wide baseline conditions |
| | Aquatic Nuisance Species Eradication | Manage in cooperation with other entities | Improve site-specific baseline conditions |
| | Unauthorized & Trespass Structures | Inventory<br>Determine ownership<br>Assess impacts<br>Improve installation, maintenance, & location<br>Authorize<br>Remove if derelict or abandoned | Improve site-specific baseline conditions |
| | Public Use & Access | Promote & encourage use consistent with the reserve objectives<br><br>Determine if additional public access is needed | Promote appropriate use of reserve |

| LOCATION | MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | GOAL |
|---|---|---|---|
| | Transient Public Recreational Use | Encourage appropriate, legal recreational activities<br>Inventory types, magnitude, and location of recreational uses<br>Determine if such uses contribute to impacts to the resources of the reserve<br>Collaborate with user groups on voluntary basis<br>Implement voluntary actions to reduce impacts | Promote use of reserve<br>Maintain or improve reserve-wide baseline conditions |
| | Outreach & Education | Place signs & boundary markers<br>Disseminate BMPs to local residents, user groups, and lessees<br>Implement educational activities<br>Seek funding sources & projects for adjacent lands<br>Collaborate with stakeholders to minimize offsite impacts | Design outreach that can best involve the public as well as meeting the goals of the reserve designation |
| On Adjacent Lands | Shoreline Modification | Rely on existing regulatory activities<br>Identify voluntary landowners<br>Collaborate with stakeholders to foster participation in meeting the goals of the reserve and the community<br>Identify funding sources and projects<br>Implement projects | Improve area-wide baseline conditions |
| | Non-point Source Pollution | Review past and present non-point source pollution programs<br>Identify sources of non-point pollution in area<br>Prioritize areas of concern<br>Collaborate with other entities to formulate and implement projects<br>Seek funding sources to assist in projects | Improve area-wide baseline conditions |
| | Private Docks, Floats, and Mooring Buoys | Rely on existing regulatory activities<br>Disseminate BMPs to local residents<br>Identify voluntary landowners<br>Identify funding sources and projects<br>Improve installation, maintenance, & location | Improve area-wide baseline conditions |

# Appendix O – DNR Use Management Guidance Matrix

| MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | | | PRIMARY IMPACTED RESOURCE | GOAL |
|---|---|---|---|---|---|
| | Inner Quartermaster | Outer Quartermaster | Maury Isl. E. Shore | | |
| Stormwater Outfalls | No direct discharge to reserve area. Upland treatment and infiltration to groundwater, streams, or wetlands to be re-introduced to marine waters through natural hydrologic processes. | | No direct discharge to reserve area. Upland treatment and infiltration to groundwater, streams, or wetlands to be re-introduced to marine waters through natural hydrologic processes - OR - might consider discharge area of impact to extend beyond the boundary of influence or habitat of concern (eelgrass, herring holding area, salmon migratory habitat, near shore zone). | Water quality, nutrient input, toxics, sediment input, flow rate, mixing, temperature, dissolved oxygen, salinity. | No shellfish closures due to water quality concerns.<br><br>Meet Clean Water Act standards.<br><br>Maintain sediment quality. |
| Sewage Outfalls | No direct discharge to reserve area. Upland treatment and infiltration to groundwater, streams, or wetlands to be re-introduced to marine waters through natural hydrologic processes. | | No direct discharge to reserve area. Upland treatment and infiltration to groundwater, streams, or wetlands to be re-introduced to marine waters through natural hydrologic processes - OR - might consider discharge area of impact to extend beyond the boundary of influence or habitat of concern (eelgrass, herring holding area, salmon migratory habitat, near shore zone). | Water quality, nutrient input, toxics, sediment input, flow rate, mixing, temperature, dissolved oxygen, salinity. | No shellfish closures due to water quality concerns.<br><br>Meet Clean Water Act standards.<br><br>Maintain sediment quality. |

<table>
<tr><th rowspan="2">MANAGEMENT ACTIVITY</th><th colspan="3">MANAGEMENT ACTIONS</th><th rowspan="2">PRIMARY IMPACTED RESOURCE</th><th rowspan="2">GOAL</th></tr>
<tr><th>Inner Quartermaster</th><th>Outer Quartermaster</th><th>Maury Isl. E. Shore</th></tr>
<tr><td>Water Intakes</td><td colspan="3">No intakes near fish spawning, migratory, or rearing areas. Intakes should generally be placed deeper than -30 ft. MLLW. All intakes must adhere to WDFW screening criteria.</td><td>Removal or destruction of habitat and disruption of fish larval dispersal. Direct entrainment of marine species.</td><td>No loss of juvenile fish or adult crustaceans related to intakes.<br><br>No destruction of aquatic habitat related to intakes.</td></tr>
<tr><td>Desalinization Facilities</td><td colspan="2">Same as "intake" above. No discharge of desalination wastewater or concentrated minerals to marine waters.</td><td>Same as "intake" above. No discharge of concentrated minerals to marine waters. Prefer no direct discharge of wastewater to reserve area - OR - might consider discharge area of impact to extend beyond the boundary of influence or habitat of concern (eelgrass, herring holding area, salmon migratory habitat, near shore zone).</td><td>Water quality, habitat disruption, direct entrainment of marine organisms.</td><td>No loss of juvenile fish or adult crustaceans related to desalinization intakes or outfalls.<br><br>No destruction of aquatic habitat related to desalinization intakes or outfalls.<br><br>Maintain existing ambient salinity levels.</td></tr>
<tr><td>Cable Crossings</td><td colspan="3">Permissible. Required to route cable around or drilling below critical habitat. Must avoid all surface and sub-surface impacts to critical aquatic habitat and species. Proponents must survey and video seabed to show proposed installation site is free of vegetation. Installation period must comply with WDFW in-water work periods. Prefer that shore-ends use directional drilling or rock-pinning/split-pipe remedial protection if the shore-end is either rocky or an erosion area. When burial is an acceptable installation method, plowing is the preferred method over water-jetting remote operated vehicle.</td><td>Aquatic vegetation, other aquatic rearing and migratory habitat, disruption of near shore drift, localized habitat degradation.</td><td>No disturbance of vegetated areas during construction.<br><br>No post construction project footprint on surface within euphotic zone.</td></tr>
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| MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | | | PRIMARY IMPACTED RESOURCE | GOAL |
|---|---|---|---|---|---|
| | Inner Quartermaster | Outer Quartermaster | Maury Isl. E. Shore | | |
| Oil, gas, water, and other pipelines | Same as cable crossings. Additionally, pipelines must be directionally drilled below the reserve to depths of minus 70 feet at MLLW or 1/2 mile from the MHW line. The project proponent must demonstrate the ability to detect leaks of less than 0.1% of total flow for each segment. | | | Aquatic vegetation, other aquatic rearing and migratory habitat, disruption of near shore drift, localized habitat degradation. | No disturbance of vegetated areas during construction. No post construction project footprint on surface within euphotic zone. Protect reserve resources from leaks of toxic chemicals. |
| Fish Pens | Not permissible. | Conditional - Herring holding in pens is not permitted during periods of herring spawning (Jan. through mid-April). In addition, pens being utilized to hold herring may only be sited in areas of adequate flushing to ensure there are no water quality impacts. No floating aquaculture facility may be located over aquatic vegetation or documented spawning habitat and shall not be located in the intertidal zone. | | Aquatic vegetation, other rearing and migratory habitat, water quality, euphotic zone, herring spawning habitat. | Herring disease levels consistent with pre-project baseline conditions.<br><br>No disturbance to aquatic vegetation or euphotic zone. |
| State Commercial Geoduck Harvest | Only on commercial tracts and performed with no impacts to aquatic habitat and species identified in the management plan. Harvest must be consistent with the guidance established in the FSEIS for the state commercial geoduck fishery and associated management plan. | | | Aquatic vegetation, migration, spawning and rearing habitat, intertidal substrate. | No disturbance of aquatic vegetation. No long-term turbidity increases. No disruption of fish spawning or rearing. |
| Shellfish Aquaculture | Permissible with no impacts to conservation features of aquatic habitat and species identified in the management plan. Use of herbicides and pesticides, cutting, tilling, or otherwise disturbing native aquatic vegetation is not permissible. | | | Aquatic vegetation, migration, spawning and rearing habitat, intertidal substrate. | No disturbance of aquatic vegetation. No long-term turbidity increases. No disruption of fish spawning or rearing. |
| Marinas and Public Docks | Existing marinas permissible with long-term management plan that outlines time frames for upgrades to reduce impacts. New Marinas - Contingent on siting study to be conducted for the reserve in coordination with local user groups and | | Contingent on siting study to be conducted for the reserve in coordination with local user groups and applicable local, state, and | Euphotic Zone, aquatic vegetation, water quality, sediment contamination, hydrologic alterations, | No disturbance of aquatic vegetation. Meet Clean Water Act standards. Maintain sediment |

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<tr><td></td><td colspan="2">applicable local, state, and federal government agencies.</td><td>federal government agencies.</td><td>and fish predation.</td><td>quality.<br>No disruption of fish spawning or rearing.</td></tr>
<tr><td>Breakwaters on State Land</td><td colspan="3">Conditional - Limited to only floating breakwaters and specific uses that can show the immediate need for facility, structural, or private property protection to alleviate risk of eminent damage. Must be designed to promote circulation and minimize barriers, limit shading, and use environmentally neutral materials.</td><td>Hydrologic alterations, drift cells, aquatic vegetation, and fish predation.</td><td>No disturbance of aquatic vegetation.<br>Promote natural hydrologic regime.<br>Avoid drift cell disruptions.<br>No disruption of fish spawning, rearing, or migration.</td></tr>
<tr><td>Boat repair facilities on state land</td><td colspan="3">Not permissible.</td><td>Water quality and contaminated sediment.</td><td>Meet Clean Water Act standards.<br>Maintain sediment quality.</td></tr>
<tr><td>Industrial Wharves and Piers</td><td colspan="2">Conditional- only if new structure creates no net additional impacts (no net loss) to the habitat and species identified for conservation at the site, and implements actions to primarily serve the purpose of the reserve.</td><td>Limited to area adjacent to upland mineral zoning in King County Comprehensive Plan. Conditional only if new structure creates no net additional impacts (no net loss) to the habitat and species identified for conservation at the site, and implements actions to primarily serve the purpose of the reserve. Existing facilities must upgrade their facility to reduce impacts over time.</td><td>Water quality, hydrologic alterations, drift cells, aquatic vegetation, and adverse species interactions.</td><td>No disturbance of aquatic vegetation.<br>Promote natural hydrologic regime.<br>Avoid drift cell disruptions.<br>No disruption of fish spawning, rearing, or migration.</td></tr>
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<tr><th>Inner Quartermaster</th><th>Outer Quartermaster</th><th>Maury Isl. E. Shore</th></tr>
<tr><td>Mooring Areas, Recreational Mooring Buoys, and Private Recreational Docks on State-Owned Aquatic Lands</td><td colspan="3">DNR will inventory existing buoys and establish ownership; cooperate with owners to identify appropriate installation methods, locations, and maintenance practices; and authorize buoys on state-owned aquatic lands (adjacent landowners may install and maintain a recreational dock or mooring buoy at no fee). Until the inventory actions are completed, existing mooring areas will be allowed to remain. In the future, DNR would remove abandoned buoys, ensure proper installation, and promote public awareness of location of eelgrass and forage fish spawning locations.</td><td>Aquatic vegetation, forage fish spawning and rearing habitat, water quality.</td><td>No disturbance of aquatic vegetation.<br>Meet Clean Water Act standards.<br>Maintain sediment quality.<br>No disruption of fish spawning, rearing, or migration.</td></tr>
<tr><td>Residential Use (Live Aboards)</td><td>Limited to existing marinas and according to the limitations of DNR regulations in WAC 332-30-171 and King County Shoreline Master Program.</td><td colspan="2">Reference marinas and public docks section above.</td><td>Water quality, hydrologic alterations, drift cells, aquatic vegetation, and adverse species interactions.</td><td>No disturbance of aquatic vegetation.<br>Meet Clean Water Act standards.<br>Maintain sediment quality.<br>No disruption of fish spawning, rearing, or migration.</td></tr>
<tr><td>Log Storage/Booming</td><td colspan="3">Not permissible.</td><td>Euphotic zone, substrate, aquatic vegetation, sediment quality.</td><td>No disturbance of aquatic vegetation.<br>Meet Clean Water Act standards.<br>Maintain sediment quality.</td></tr>
<tr><td>Dredging</td><td colspan="3">Not permissible unless for federal transportation projects.</td><td>Substrate, water quality, aquatic vegetation, fish spawning, rearing, and migration.</td><td>No disturbance of aquatic vegetation.<br>Meet Clean Water Act standards.<br>Maintain sediment quality. No disruption of fish spawning, rearing, or migration.</td></tr>
<tr><td></td><td colspan="3"></td><td></td><td></td></tr>
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| MANAGEMENT ACTIVITY | MANAGEMENT ACTIONS | | | PRIMARY IMPACTED RESOURCE | GOAL |
|---|---|---|---|---|---|
| | Inner Quartermaster | Outer Quartermaster | Maury Isl. E. Shore | | |
| MTCA/CERCLA Sites | Support reserve conservation goals and manages uses within the reserve to prevent future sediment contamination. | | | Sediment quality, water quality. | Meet Clean Water Act standards. Maintain sediment. quality. |
| Voluntary Restoration and Enhancement | Encouraged throughout the reserve based on recognized priorities. DNR will review existing inventories of potential restoration activities and in voluntary cooperation with interested parties will develop a site specific prioritization; secure funding for habitat improvement projects; and implement projects within the reserve. | | | Euphotic zone, aquatic vegetation, water quality, sediment quality, hydrologic alterations, drift cells, fish populations and habitat. | Maintain and improve aquatic habitat conditions within the reserve. |
| Mitigation | Projects within reserve must be fully mitigated and compensatory mitigation must be installed prior to project-related impacts occurring. Mitigation activities for projects outside of the reserve must improve aquatic habitat conditions within the reserve. | | | Euphotic zone, aquatic vegetation, water quality, sediment quality, hydrologic alterations, drift cells, fish populations and habitat. | Maintain and improve aquatic habitat conditions within the reserve. |